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## COMPLICATIONS OF GALLBLADDER SURGERY<sup>\*</sup>

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COMPLICATIONS of gallbladder surgery may be reviewed as (1) mechanical, (2) chemical, (3) metabolic, and (4) infectious. The complications that occur within the first 24 hours after operation are obviously those that are associated with hemorrhage, gastric dilatation, embolism, pulmonary collapse, and cardiac dilatation. The early complications are those that arise from mechanical or infectious causes, such as intestinal obstruction, volvulus, pyloric occlusion, peritonitis (local or general), subphrenic abscess, or retroperitoneal phlegmon. From the purely chemical background certain complications occur, secondary to continuous and repeated vomiting, such as alkalosis, hypochloremia, and hypohydration, or the acidosis from intractable diarrhea, or the complications of obscure or perverted liver chemistry—"liver deaths."

It is apparent that the postoperative complications in gallbladder surgery must be considered in reference to the operative procedures. Complications occurring after cholecystectomy or cholecystostomy are different from those that arise from surgery of the common duct. The association of cholelithiasis and carcinoma of the gallbladder is so well known as to require very little comment. The development of carcinoma after cholecystectomy or cholecystostomy, while extremely infrequent, is occasionally met with, and raises the question as to whether the malignancy was present at the time of the first operation. It is not a rare experience for a general surgical service to have a so called "cure" for a clinically diagnosed carcinoma of the pancreas from a cholecystogastrostomy. There is always some degree of pathologic change in the wall of the common duct in every case of chronic gallbladder infection, and over 20 per cent of all patients with the symptomatology of gallbladder disease have liver and pancreatic involvement.

There is an abundant literature on the uncured cases of gallbladder surgery—the patients that have a continuance of their symptoms, or originate a new syndrome after surgical intervention. Complications do arise from mistaken diagnosis, from chronic glissonitis or fibrous perihepatitis, from continuing cholangitis, from chronic interstitial pancreatitis, from benign stricture of the common duct, and from what has been inaptly called the

<sup>\*</sup> Read as part of a Symposium on Complications of Gallbladder Surgery before the New York Surgical Society, March 11, 1936. Submitted for publication May 19, 1936.

postcholecystectomy syndrome, or by its new appellation—the “biliary dyskinesia,” or sphincteritis of Oddi

In order to visualize the subject matter of this paper, an analysis was made of 557 personal cases, both waid and private, that were submitted to laparotomy for diseases of the gallbladder or the external biliary duct system. It seemed pertinent to inquire: How many of these patients survived surgery? And of those who died: What was the mechanism of death? Were the pre-operative preparation, the surgical intervention, and the postoperative therapy competent and adequate? Furthermore, could any reasonable deductions be made as to the complications and mortality that would serve to prevent their occurrence in any future group of patients? All the patients were personally operated upon by the author, so that the descriptive terms used are common to his habit of mind, and probably differ little from case to case. To be sure, a better showing could be made if the analysis had been confined to private patients alone. Irrespective of the competency of the surgeon, the relative physical well being, the stage of the disease, and the patient's hereditary background are factors of undoubted importance in insuring recovery after surgical intervention. It seemed wiser, however, to take the “run of the mill,” for the conclusions derived therefrom would be applicable to the gallbladder service in any general hospital of like prominence and bed capacity.

TABLE I  
STATISTICAL RÉSUMÉ OF BILIARY TRACT SURGERY

Classification	Total	Per Cent
Number of gallbladder cases	557	
Males	143	25.7
Females	414	74.3
Cholecystectomy	500	89.7
Choledochotomy	26	4.6
Cholecystostomy	34	6.1
Cholecystectomy plus appendicectomy	363	72.6
Cholecystectomy plus choledochotomy	12	2.1
Cholecystectomy or choledochotomy plus stomach operation	55	9.8
Cholecystogastrostomy	5	.89
Cholelithiasis	330	59.2
Noncalculous cholecystitis	222	39.8
Associated with ulcer of the stomach or duodenum	59	10.5
Associated with jaundice	91	16.3
Associated with pancreatitis	21	3.7
Associated with fibroids	54	13.0
Associated with diabetes	5	.89

The observer is impressed with the comparative rarity of subphrenic abscess as a complication of gallbladder disease. There were only two recorded instances of this condition in the series. It would seem reasonable to suppose that subdiaphragmatic infection could be expected in a higher percentage of cases. Our experience has been that subphrenic abscess is usually sequential to suppurative appendicitis and gastroduodenal ulceration. The roentgenologist, however, not infrequently reports subdiaphragmatic pathology when the roentgenograms are taken within the first week or ten days after a gallbladder operation. Sterile or infected bile does escape in approxi-



mately 10 per cent of gallbladder operations, and makes its way into the posterior superior portion of the right subdiaphragmatic space. Fixation or even elevation of the right diaphragm would then be a roentgenographic finding. It is rarely, however, that this condition leads to abscess formation, as the majority of these infections subside spontaneously.

Cholecystectomy for chronic gallbladder disease is one of the safest of all intra-abdominal operations, and in the hands of a reasonably well trained surgeon is relatively free from postoperative complications. Operations upon the gallbladder or bile ducts when in an acute inflammatory phase are associated with an increase in the technical difficulties, and the development of complications. An operation undertaken upon a patient with obstructive jaundice is associated with greater technical difficulties, and a very marked increase in the frequency of complications. This is evidenced by an ascending mortality scale. In 500 noncomplicated cholecystectomies, the mortality rate was 3.3 per cent. Yet in 34 cases of cholecystostomy for acute cholecystitis, there were five mortalities, or 14.7 per cent. In 500 cases of cholecystectomy, the appendix was removed in 363, or 72.6 per cent of the cases. There were 55 patients, or 9.8 per cent of the series, who required in addition to surgery of the gallbladder or biliary duct another major operative procedure—gastro-enterostomy, gastric resection, or pyloroplasty.

Postoperative hemorrhage in patients operated upon for obstructive jaundice due to common duct disease is a formidable danger. Preoperative therapy has for its object the obtaining of two desirable conditions: (1) To make the surgery safe for the patient, and (2) to render the patient safe for the surgery. Preoperative therapy for bleeding, while fairly satisfactory, is by no means adequate. In the postmortem examination of patients who have died after common duct operation for obstructive jaundice there was found in the peritoneal cavity in 40 per cent of the patients an amount of intra-peritoneal blood that was a complicating factor in producing death. This postoperative capillary bleeding occurred in individuals who had been rendered relatively safe by obtaining a normal bleeding time, and a safe coagulation time before operation.

Acute or subacute pancreatitis is a complication of gallbladder surgery with great mortality possibilities. I do not refer to fulminating hemorrhagic pancreatitis, but indicate a pancreatitis characterized by acute edema of the head of the pancreas, pressure necrosis of the capsule, and the escape of pancreatic ferment. The possibility of pancreatitis should be anticipated when a male patient is seen during an acute attack, and presents a history of gallbladder disease. In addition to the general clinical picture of gallbladder disease with biliary colic, there are certain significant features not ordinarily present in the gallbladder history. The patient complains of intense pain transversely above the navel and extending across both sides of the abdomen, and at almost the same location across the back. The temperature remains constantly elevated, and there is always some degree of icterus.

On opening the abdomen the surgeon should be on the alert for small areas of fat necrosis. These may occur as minute white semicrystalline deposits on the omentum or gallbladder. The gallbladder is edematous and

usually contains stones. Marked hypervascularization exists through the entire right upper quadrant. The gallbladder will ordinarily be surrounded by the omentum, and the foramen of Winslow will be obliterated by fibrinoplastic lymph material. On separating the omentum a peculiar "prune juice" fluid escapes from Morrison's space. This fluid is a very intense chemical ferment, and produces a pale green, gangrenous area wherever it contacts.

Pancreatitis occurred 21 times as a complication in 557 cases of gallbladder disease, representing 3.7 per cent of the series, with five deaths, or a mortality of 23.8 per cent. It occurred five times as frequently in the male as in the female. The causes of death in the gallbladder cases complicated by pancreatitis were as follows: (1) auricular fibrillation, death occurring on the eighth postoperative day, (2) pulmonary embolism, the patient dying at the end of 48 hours, (3) retroperitoneal phlegmon, with death on the twelfth day, (4) peritonitis, death occurring on the eleventh day, and (5) wound dehiscence with secondary intestinal obstruction, when the patient died on the twenty-second day. It is an interesting observation that the immediate postoperative condition of the male with a gallbladder and pancreatic condition is as a rule more disturbing and complicated than a similar condition in the female, yet the eventual relief of symptoms in the male is equal if not better after full recovery than that which obtains in the female.

In the 557 cases there were 13 malignancies of the gallbladder or ducts, representing 2.3 per cent of the material. All the cases of malignancy were jaundiced, all had gallstones, two were associated with nonmalignant duodenal ulcer, and four died in the hospital, the remaining dying within ten months after leaving the hospital. In one of these patients a resection of the adjacent liver was carried out, with no apparent increase in longevity. Carcinoma of the gallbladder *per se* is not the insurmountable difficulty, but it is the dense metastatic glandular deposits along the hepatic and common ducts, bringing about the inevitable compression and occlusion, with continuous deepening jaundice, that render the condition beyond the resources of surgical intervention. Mechanical hemorrhage from a nonligated vessel, in contradistinction to capillary bleeding in jaundice, is, under present technical conditions, seldom a complicating factor. Visible secondary hemorrhage was noted in only three instances, and in none of these individuals was it anything but an embarrassing feature. The bleeding occurred from branches of the superior epigastric and was not in any way noteworthy.

The frequency of gallstones increases with each decade of life. Gallstones were found by Gross in 8 per cent of 9,531 postmortem examinations, 8.1 per cent of the gallstones being found in the fourth decade, 14.7 per cent in the fifth and 21.2 per cent in the sixth. In our series, gallstones were present in 59.2 per cent of the cases, being absent in 39.8 per cent. The average age of the patient at operation was 40.4 years, the youngest being eight years of age, and the oldest 79.

The ascending age incidence of gallstones parallels the normal or pathologic degenerative changes in the human being. It is as a matter of clinical observation that the best results in gallbladder surgery are obtained in the young individual, and that the postoperative sequelae of indigestion and pain

are more apt to continue in the patients who have surgery in the fifth, and even more so in the sixth, decade

In 414 female patients, 54 or 13 per cent of the series had fibromyomata, and 59 or 10.5 per cent had ulcer either of the stomach or duodenum. In 500 cases of cholecystectomy there were 16 deaths, representing a mortality of 3.7 per cent. Four died of pneumonia, two of myocarditis, one of *Streptococcus* septicemia on the sixteenth postoperative day. There were two deaths from embolism, one from intestinal obstruction following dehiscence of the laparotomy wound, two from peritonitis, in one of which there was gangrene of the ascending colon on which avertin was employed. There were eight liver deaths—two with hyperpyrexia and coma, and three with diminishing jaundice and coma, and three with hepaticorenal syndrome. Of the 16 deaths, 15 had calculous gallbladders, one was a noncalculous cholecystitis, and one was a secondary cholecystectomy for a retained calculous gallbladder.

In 557 gallbladder cases, cholecystostomy was performed 34 times, with five deaths, representing a mortality of 14.7 per cent. Four of the five cases had biliary calculi, and all were gangrenous. Three had had spontaneous perforation with free fluid in the peritoneal cavity. The cause of death was assigned as follows: peritonitis—three cases, myocarditis and nephritis—one case, acute yellow atrophy of the liver—one case. There were two deaths following cholecystostomy plus choledochotomy. One occurred on the thirty-third postoperative day from cardiorenal disease, and the other occurred in a patient markedly jaundiced and in a semicomatose condition. The operation was performed under local anesthesia, and the patient died at the end of 36 hours, in coma. One patient died in coma from hepatic degeneration with intense nonobstructive jaundice. We have attributed this mortality to chronic arsenical poisoning. Two deaths occurred in patients having secondary operations on the gallbladder tract. One mortality followed duodenorrhaphy, with a posterior gastro-enterostomy for a cholecystoduodenal fistula. A second mortality occurred in a patient having a choledochogastrostomy performed for stenosis of the common duct, following a cholecystectomy performed elsewhere.

Of more importance, and about which we have very little substantial knowledge, is the condition of the liver, both immediately before operation and its career subsequent to surgical intervention. The multiplicity of functions exercised by the liver and the inadequacy of any test at the present time to give a real picture of hepatic function render the preoperative appraisal of liver function extremely difficult. Continental observers have described in numerous publications a condition of liver insufficiency. When it is recalled that deficiency of liver function may exist in any one of a number of categories, and yet at the same time the liver may exercise normal function in its other properties, it is difficult to determine any specific type of hepatic insufficiency by any of the standards of measurement that we now possess. It seems reasonably clear that there are grades of hepatic degeneration which follow relatively mild infections, and exhibit themselves as catarrhal jaundice, or as the more grave and lethal condition of acute yellow atrophy.

TABLE II

STATISTICAL RESUME OF MORBIDITY AND MORTALITY FOLLOWING GALLBLADDER SURGERY		
Classification	Total	Per Cent
Number of gallbladder cases	557	
Average age	40 4 yrs	
Age of oldest patient	79 yrs	
Age of youngest patient	8 yrs	
Duration of stay of cholecystectomy group	16 4 days	
Duration of stay of common duct group	21 9 days	
Deaths after cholecystectomy	16	3 3
Deaths after cholecystostomy	5	14 7
Deaths from pancreatitis complicating gallbladder disease	5	23 8
Deaths from malignancy of the gallbladder or ducts (hospital deaths)	4	
Deaths from gallbladder disease complicated by stomach or duodenal ulceration	9	16 1
Total deaths	39	7 0
Liver deaths	8	20 5
Postmortems	7	17 8
Dehiscences	4	7
Secondary hemorrhages	3	5
Intestinal obstruction subsequent to operation	3	5
Malignancies	13	2 3

In previous publications<sup>1, 2</sup> we have indicated the effect of the edema of the liver parenchyma as it occurs with degeneration of the liver cells. It is interesting to speculate as to what permanent damage is done to the liver after a long period of obstructive jaundice. Experimental evidence is abundant that regeneration of liver substance takes place with surprising rapidity. But what degree of fibrous or cicatricial repair has taken place in the liver during recovery, and how great is the permanent effect of the fibrosis that remains in the liver? We have been impressed in the course of surgical intervention for gallbladder disease to find varying degrees of fibrous hepatitis, the leathery character of the liver, its changes in color, and it is our impression that postoperative localized residual pain in the general area of the liver, particularly in the midaxillary line, is the result of sensory nerve disability from a chronic glissonitis.

On October 24, 1923, I presented before this Society a paper entitled "The Liver and Its Relation to Chronic Abdominal Infection"<sup>3</sup>. In this connection I must borrow from my former self, on the old Greek principle that a man may once say a thing as he would have said it, but he cannot say it twice. The complications that may reasonably be expected after laparotomy for gallbladder disease are clearcut and distinct, and possess within certain limits a chronologic sequence. In the first 24 hours the complications are anatomic, such as hemorrhage, shock, gastric dilatation, and embolism. In the succeeding 48 to 72 hours the element of infection might possibly come into play, with the production of a peritonitis, and still later, abscess formation. We have observed occasionally three clinical states that supervene after operations on the gallbladder and biliary system, and more rarely after gastric or intestinal surgery, and which cannot be attributed to any of these factors. Although these clinical complications are comparatively rare, yet they are

definite, and apparently within their group are rather characteristic in their symptomatology. The most common type of chemical or so called "liver deaths" have been those associated with hyperpyrexia and coma. The operation has been one of relatively simple technical performance in a patient whose general metabolism was considered satisfactory before operation and in whom adequate renal function had been determined. Almost immediately from the time of operation there is a continuously ascending temperature, with a rapidly developing lethargy, stupor and coma, and death terminates the picture in 18 to 36 hours. A second type, somewhat less frequent than the first, occurs in patients who have had an operation for the relief of obstructive jaundice and in the course of a rather normal convalescence, about the fourth or fifth day, and in the presence of a constantly diminishing jaundice as indicated by the icterus index, they slowly pass into a stupor and coma and the exodus is in no way dissimilar from the cholemic death that occurs in unrelieved obstructive jaundice. A third type, perhaps, is associated with some unrelated kidney pathology, for anuria is a factor in the terminal picture. Previous to operation these patients have had what was considered normal renal function and no question was in the mind of the surgeon as to the competency of the kidney to carry on its function in the presence of an operative intervention. Forty-eight hours after an operation on the gallbladder or common duct the patient, quite rapidly, presents a picture not dissimilar from shock, with cold, clammy skin, gradual failure in water elimination and a rise in the urea nitrogen. The urinary output becomes less and less, and a mild delirium develops with increased frequency of pulse and temperature and finally coma and death. These patients were not jaundiced either before or after operation, and there is a distinct interval of apparently normal postoperative conduct of from 24 to 36 hours between the operation and the onset of the terminal clinical picture. Whether these three types are clinical entities or not is not important at the present time. They serve as indications or examples of a complex chemical problem presented to gallbladder surgeons.

In the 39 mortalities in our series of 557 cases, there were eight which could not be ascribed to the ordinary causes of death. Two of the cases were characterized by hyperpyrexia and coma, following very shortly after surgical intervention and progressing to death. Three cases were operated upon for chronic obstructive jaundice, and after varying intervals of five to seven days of good postoperative progress, and in the presence of a diminishing icterus, slowly developed coma and died. There were three cases, two cholecystectomies and one a cholecystectomy, that at the end of 24 to 36 hours developed a pronounced cardiorenal collapse, with cold, clammy skin, presenting the picture of profound shock, and slowly but progressively failed and died.

While clinical observation has remained substantially correct, the interpretation must await further experimental evidence. The third group is apparently linked up with hypohydration, and the interpretation of the blood chemistry with a high nonprotein nitrogen is significant only by reason of

the great demand on the part of the patient for the preservation of his preferential water. It requires a certain urine water volume to carry away the excrementitious chemicals, and with any great loss of urine water volume there is a backing up of nonprotein nitrogen in the blood. The continuance of this blood retention certainly invokes a vicious circle, and establishes a repetitive assault upon a liver that is already beginning to fail.

#### CONCLUSIONS

(1) That certain mortalities from the very nature of the disease cannot be prevented. The 13 malignancies in this series at the time of operation were beyond any remedial measures. It is highly significant that all of them had gallstones and symptoms of long continued gallbladder disease. Surgical intervention at a period of early symptomatology would have completely obviated this group of mortalities.

(2) A gallbladder disease characterized by biliary colic means the interplay of two factors: (a) the mechanical effect of the calculus, and (b) the rapid increase in the degree of infection. The high percentage of mortality in the cholecystostomy cases is directly attributable to surgical procrastination. Four out of five patients had calculi. It seems axiomatic that biliary colic provides one of the surest indications for surgical intervention.

(3) Biliary disease characterized by colic, in males, carries with it a very definite possibility of pancreatitis, with its high operative mortality.

(4) Grave cardiovascular renal disease and pneumonia account for a considerable group of, so far as we know, unpreventable mortalities. Their lethal possibilities can be lessened by longer preoperative therapy.

(5) There is a striking contrast in the ability of patients to withstand the ravages of gallbladder disease, and the surgery necessary for its correction. This resistance depends upon the social, economic, and nutritional level of the patients. Of the 557 patients, 417 were private and 140 were clinic patients. Of the 417 private patients, 20 died, giving a gallbladder mortality in private patients of 4.8 per cent. In the 140 clinic patients, 19 died, giving a gallbladder mortality in clinic patients of 13.5 per cent. This noteworthy difference of mortality rate between private and clinic patients is due to the greater degree of pathologic damage in the clinic patient as the result of delay in seeking surgical intervention at an early stage of the disease.

(6) With due consideration of all of the factors involved—the type of lesion, the biologic background of the patient, the adequacy of surgical intervention, the complications and the mortalities—still, surgery for gallbladder disease is safe and highly satisfactory.

#### REFERENCES

- <sup>1</sup> Heyd, C. G. *Am Jour Digestive Diseases and Nutrition*, 1, 203-206, May, 1934.
- <sup>2</sup> Heyd, C. G. *ANNALS OF SURGERY*, 77, 146-150, January, 1928.
- <sup>3</sup> Heyd, C. G. *ANNALS OF SURGERY*, 67, 55-77, January, 1924.

# MORTALITY IN SURGICAL DISEASES OF THE BILIARY TRACT<sup>1</sup>

AN ANALYSIS OF ONE HUNDRED AND THIRTY AUTOPSIES

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THE past two decades have witnessed a gradual and progressive decrease in the general surgical mortality reported by the larger clinics. In addition to earlier diagnosis and improved surgical technic, this may be attributed to a better understanding of the pathologic, physiologic and chemical changes occurring in the course of disease. As a result of this increased knowledge, a better selection of cases has become possible as well as the election of the most opportune time for operative intervention. The surgical treatment of obstructive and infectious processes affecting the biliary tract has shared in this general advance. Many important problems remain, however, which must be solved before the mortality statistics in this group of cases can be viewed with satisfaction.

The present study is based upon 130 consecutive postmortem examinations of biliary tract disease gathered from the ward services of the Mount Sinai Hospital, New York City. These include deaths following operations and those cases of nonmalignant disease which were admitted in such desperate condition that operation could not be undertaken. Many of the deaths represent the unavoidable end-results of the economic circumstances prevalent in any group of patients admitted to the wards of the average large metropolitan hospital.

A consideration of the causes of death immediately discloses that from the practical standpoint, they fall into three major groups. In the first group the disease itself was the ultimate cause of the fatal issue. The opinion is still too widely held that cholecystitis and cholelithiasis are relatively benign and harmless conditions subjecting the patient to minor digestive complaints and an occasional severe attack of colic, which can be readily controlled by morphine. The knowledge that cholelithiasis and biliary infections are very often clinically silent, although actually treacherous foci of chronic infection and obstruction, should be more widely diffused. A prolonged period of persistent low grade infection and partial obstruction induces local and systemic changes which weigh the odds heavily against successful surgery. Indeed, either a sudden unaccountable accession of virulence in the infective process, or a superimposed complete obstruction, inevitably earmarks many of these cases for death regardless of the acuity of judgment, the facility of technic,

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or the postoperative care afforded to them. This group includes cases of acute diffuse peritonitis complicating acute cholecystitis and perforation of the gallbladder, calculus suppurative cholangitis, suppurative pylephlebitis and hemorrhage associated with obstructive jaundice.

In the second group, (II-A) are the so called interval cases in which the disease at the time of operation was not threatening to life. Death in these instances may be traced directly either to errors in judgment or technic in their widest sense, or to those complications or accidents which in the present state of surgical development seem to be an unavoidable accompaniment of major surgery involving the upper abdomen. These cases consist of postoperative peritonitis, operative injuries to the extrahepatic bile ducts, postoperative pneumonia, cardiac failure, pulmonary embolism and wound rupture. Cases dying from uremia and the so called hepatorenal syndrome will also be discussed in this group. In addition, there is another small but important group, (II-B) of cases of primary hepatic disease which were mistakenly operated upon for gallbladder disease.

The third group consists of those autopsies in which carcinoma was the complicating factor.

GROUP I—*Diffuse Peritonitis*—This is not only the most important and the most common complication but the one which should be the most susceptible of surgical prevention.

Fatal cases of diffuse peritonitis in gallbladder surgery may be divided into those in which the pathology is already well developed at the time of operation and represents an extension of the infectious process from an acute cholecystitis, and those in which the operative procedure is either a directly causative or an exciting accessory factor. The type of peritonitis may be arbitrarily divided into a biliary and suppurative variety.

There were 12 cases of biliary peritonitis, six of which resulted from a perforation of an acutely inflamed gallbladder, and will be discussed under "peritonitis following acute cholecystitis," and six of which followed operation.

These particular cases of bile extravasation ran a short and usually fulminating course, probably due to the fact that the bile was infected. *B. coli* was isolated from the cultures of the peritoneal fluid made at secondary operations in three cases. The rapidly fatal outcome in these patients stood in marked contrast to the relatively benign course seen and reported either in biliary effusions secondary to nonoperative traumatic injury of the ducts, or operations on apparently noninfected gallbladders.

Five of the six cases of postoperative *biliary peritonitis* could be traced to definite technical operative errors. Accidental lateral injuries to the hepatic duct in the course of a cholecystectomy resulted in necrosis and perforation of the duct wall in two instances. In one case the extravasation of bile was the result of a false passage made in an attempt to probe the common duct with a fine probe via the cystic duct. In another, the extravasation occurred from the distal portion of the cystic and the adjacent portion of the



common duct, after the cystic duct, which had been completely split in order to remove calculi from the choledochus, was resutured. No hepatic drainage was instituted. A unique and rather unusual source of a fatal biliary leak resulted from necrosis of a portion of the gallbladder wall to which an ovarian clamp had been applied in order to facilitate freeing of the gallbladder from adhesions. Cholecystectomy, however, was not performed. This case emphasizes the inadvisability of applying a crushing clamp to the viscus unless its ablation has been definitely decided upon. The final case was one of a retroperitoneal biliary extravasation which even a postmortem examination could not clarify. The source of the leakage could not be detected after a most careful and painstaking search.

Drainage is used routinely following cholecystectomy at this institution. It is evident from these autopsies that the presence of a drain is not an absolute guarantee against the consequences of a large biliary extravasation. As a matter of fact, in two of these cases there was no biliary discharge through the tube. But if drainage were dispensed with, it is likely that biliary peritonitis would probably have been more frequent.

*Suppurative Peritonitis* occurred in seven instances following operations for chronic conditions involving the gallbladder and extrahepatic ducts. Five of these followed secondary procedures upon the ducts, and three were associated with operative injuries of the duodenum and colon. Peritoneal infections occurred twice following technically difficult and prolonged operations for subacute and chronic cholecystitis. Although both these cases were adequately drained, oozing from the liver bed resulted in the development of a subhepatic hematoma. The *Clostridium welchii* was recovered from the blood clot and wound. The clinical course, however, was not that of a gas bacillus infection, and at the postmortem the colon bacillus was recovered from the peritoneal fluid.

*Diffuse Peritonitis Resulting From Acute Cholecystitis*—Nine such cases were found at postmortem. Five had been operated upon. The other four had been admitted to the hospital in such a critical condition that any operative procedure was deemed either inadvisable or impossible. Two points were striking. In the first place, diffuse peritonitis due to perforation of the gallbladder occurred in elderly patients, one being over eighty, two over seventy, two in the sixties, and one in the late fifties. The one patient who was under fifty was extremely obese and a severe diabetic. Secondly, this fatal complication of perforation into the free peritoneal cavity apparently occurred during the first attack in half of the cases and the clinical course was so atypical in three that the only preoperative diagnosis possible was peritonitis of unknown etiology. There were altogether seven such perforations into the free peritoneal cavity, in five of which the peritoneal fluid was definitely biliary in character. In two other instances the cystic duct had apparently been blocked off long enough to permit of the absorption of the bile pigments from the gallbladder before perforation occurred.

There was a single case of rupture of a pericholecystic abscess. This oc-

curred immediately following a gastro-intestinal fluoroscopy undertaken because of the atypical character of the patient's symptoms. This episode was initiated by terrific attack of pain and shock resembling perforation of a duodenal ulcer. Operation was performed within a few hours, but the patient succumbed of peritonitis at the end of three weeks.

There was also an interesting case of diffuse biliary peritonitis associated with gangrene of the gallbladder but without any visible defect in the gallbladder wall.

It is significant that no case of diffuse peritonitis following cholecystectomy for acute cholecystitis was found, except in those cases in which a suppurative peritonitis was already present at the time of operation. Judging from this series, operation during the acute phase, as is the custom of some of the surgical services, or after the acute condition has subsided, as is the practice on the others, does not seem to materially affect the occurrence of a fatal post-operative peritonitis. This point together with the knowledge that acute peritonitis from an acutely inflamed gallbladder already present at operation, accounted for almost one-third of the deaths in acute cholecystitis found at postmortem, would seem to be very strong arguments for early operative intervention in acute gallbladder infections. However, it is important to note that most of these cases occurred in elderly patients and that in a number of instances the clinical course was very atypical. It must also be emphasized that no cases of acute gallbladder perforation were found in young or middle-aged groups who were otherwise in good health.

TABLE I

## CAUSES OF DEATH IN INSTANCES OF ACUTE CHOLECYSTITIS

Cause	Number
Peritonitis, diffuse	9
Pylephlebitis	6
Subhepatic abscess	1
Subphrenic peritonitis abscess	1
Hemorrhage	1
Duct injuries	1
Pneumonia	2
Sepsis	1
Pancreatitis	1
	—
	23

*Suppurative Calculus Cholangitis*.—This serious complication and its sequelae were the causes of death in 14 cases of gallbladder disease associated with choledochal stone. These patients were advanced in years, five being over 70, six being in the 60's, and one in the 50's. There were two patients under 50, one of whom had been subjected to a previous cholecystectomy and the other had a 20 year history during which time the gallbladder had been practically destroyed. All but one gave a history of one or more attacks of jaundice over a period of three to five years. The exception was a diabetic in whom no history of jaundice prior to the fatal attack could be obtained.

When the final attack came on symptoms developed with marked rapidity. In half the patients the illness had lasted only between two and five days before the admission to the hospital.

Of these 14 patients, six entered the hospital so desperately ill that nothing could be done and death ensued within 24 to 36 hours. All were jaundiced and had repeated episodes of fever and shaking chills. Bacteremia was present in three, *B. coli*, *B. Friedlanderi*, and a pneumococcus being recovered respectively. In these unoperated cases, postmortem revealed a complete obstruction due to the impaction of a stone in the vicinity of the ampulla in three. In the remainder, although multiple stones were present, the obstruction was incomplete.

Eight cases succumbed to the effects of suppurative cholangitis in spite of surgical interference. The general condition in four was such that operation was undertaken as a last resort, the surgeon being fully cognizant of the hopelessness of the situation. In two the condition of the patients was such that only a simple cholecystostomy was performed under local anesthesia, trusting that the drainage and decompression thus afforded would tide the patient over the critical phase of the disease. Death soon followed and at postmortem, multiple hepatic abscesses were found in three and the fourth presented a diffuse cholangitic hepatitis.

There were only four cases in which the surgeon had felt that operative intervention promised a favorable outcome. Even this hope proved unwarranted because in two the postmortem examination revealed that the disease had been more advanced than was anticipated. Multiple hepatic abscesses and a suppurative pancreatitis were present in one, while in the other, in which the gallbladder had previously been ablated, a severe diffuse cholangitic hepatitis with marked liver degeneration was found.

Errors in operative technic and judgment contributed to the fatal outcome in the two other cases. In one, cholecystectomy with ligation of the cystic duct was performed for a gangrenous cholecystitis. A stone impacted at the papilla was overlooked. In view of the fact that the patient was jaundiced, drainage of an open cystic duct would have been a better procedure. In a second instance a choledochostomy was performed and a subhepatic abscess drained. The patient did not do well postoperatively. A subphrenic abscess was suspected but its presence could not be proven even after repeated exploratory aspiration. It was found at postmortem three weeks later.

These cases of suppurative calculus cholangitis are a sad commentary on conservative medical therapy. The only method by which incidence of the high morbidity and mortality in this group may be reduced, is earlier operation instituted at a more favorable period in the course of the disease.

*Suppurative Pylephlebitis*—This complication was found to be the cause of death in six cases of acute cholecystitis and two of cholangitis. In addition, it was a contributing factor in five cases of suppurative cholangitis. It is not to be considered as an isolated lesion, but rather as the most fatal complication of a diffuse and virulent infection. Four modes of involvement

TABLE II

## CAUSES OF DEATH IN INSTANCES OF COMMON DUCT STONES

Cause	Number
Suppurative cholangitis	14
Suppurative pylephlebitis	2
Peritonitis	2
Subphrenic abscess	1
Subhepatic abscess	1
Ileus	1
Duodenal fistula	3
Hemorrhage	2
Uremia	3
"Extrarenal azotemia"	4
Pneumonia	2
Cardiovascular	2
Pancreatitis	2
Unrelieved jaundice	1
Biliary cirrhosis	1
Sepsis	1
Common duct strictures	7
	—
	49

of the portal vein were noted. The first type was characterized by a direct extension along the course of the cystic vein. In the second it resulted from a periportal abscess or a severe phlegmonous infection within the cellular tissues of the hepaticoduodenal ligament. In the third type involvement of the small veins lying upon the surface of the common duct resulted from a virulent necrotizing cholangitis. The fourth variety was characterized by the development of an abscess between the deep surface of the gallbladder and the liver. A local phlebitis of the intrahepatic radicals at this point occurred with a retrograde extension into the right branch of the portal vein. It is noteworthy that four of the cases which developed pylephlebitis on the basis of severe common duct infection occurred in cases in which the gallbladder had either previously been removed or had become shrunk and nonfunctioning as a result of cholecystostomy or prolonged disease. The gallbladder seems to act as a sort of safety valve in cases of common duct infection, and the clinical course appears to be more fulminating when this gallbladder function has been eliminated. Blood culture studies revealed the presence of *B. coli* in three instances, *B. Friedlander* in two, and *Streptococcus viridans* and *Staphylococcus aureus* each in one instance. In five of these seven instances a thrombophlebitic process was noted in the intrahepatic radicals of the hepatic vein. Multiple pylephlebitic liver abscesses were found in four of the six cases complicating an acute cholecystitis. In the cases associated with cholangitis, liver abscesses of pylephlebitic origin were found twice.

The clinical picture was variable. In some there was a fulminating course with death within the first week. Others presented a more classic picture of pylephlebitis with a septic temperature and recurrent chills which at times

lasted for weeks. In two instances the infectious processes seemed to undergo a certain subsidence and a uremic picture predominated. Postmortem in one of the latter instances showed that the still active suppurative focus had been blocked off from the venous circulation by obturating thrombi which extended backward into the splenic, gastric and superior mesenteric veins.

Reviewing these cases from the standpoint of possible operative intervention, only one case was noted in which earlier operation might have been successful. This patient had been treated conservatively for one week, during which time evidences of a severe gallbladder infection became more marked. Operation revealed that an abscess had developed between the gallbladder and the liver bed from which a fatal pylephlebitis developed.

*Hemorrhage*—There were no fatal hemorrhages due to a technical failure to adequately secure the cystic vessels in the course of a cholecystectomy. In one instance, however, the control of a severe hemorrhage was achieved only after injuring the hepatic duct. The one fatal hemorrhage from the cystic vessels occurred ten days postoperatively in a case in which a cholecystostomy and drainage of a pericholecystitic abscess had been performed. Autopsy disclosed the source of bleeding to be from an erosion of the cystic artery. This was the result of sloughing at the junction of the ampulla of the gallbladder and the cystic duct. No fatal hemorrhage occurred from the liver bed in nonjaundiced cases. The formation of a subhepatic hematoma, however, provided a nidus for the development of a fatal peritonitis in two instances.

Hemorrhage in obstructive jaundice due to stone was dependent usually on factors aside from technical errors. Postoperative exsanguinating hemorrhage *per se* accounted for only three deaths even in these exceptionally poor operative risks. The tendency to fatal hemorrhage seemed to bear no constant relationship to the intensity of the icterus. The van den Bergh test in three of these cases was 6.5 mg, 3.0 mg, and 1.0 mg, respectively. These three cases were afebrile and complained of a rather severe pruritus. In all of them choledochostomy had been supplemented by cholecystectomy. The latter procedure with its potential source of hemorrhage from the gallbladder bed is especially dangerous and should be avoided if possible in cases of common duct obstruction with jaundice.

White bile was present in the common duct in one instance. The fatal hemorrhage commenced on the fifth day in two patients and on the tenth day in the third. There was a definite increase in the jaundice following hemorrhage. This was due to bleeding into the common duct with subsequent clot formation and the recurrence of an obstructive jaundice in one case. Hemorrhage severe enough to be fatal occurred in nine of 26 deaths associated with carcinomatous obstruction, and in two of seven deaths associated with strictures of the duct. The relatively small incidence of fatal hemorrhage in cases of stone may be partially accounted for by the fact that many deaths occurred from an overwhelming infection at a period before the tendency to bleed had become fully developed.

It must be emphasized that these figures reveal only the cases of *fatal* hemorrhages found at postmortem. Severe postoperative hemorrhage is still quite common in jaundiced patients. The repeated use of small transfusions and glucose intravenously have apparently been potent factors in reducing the number of fatalities formerly attributable to this cause.

From a clinical standpoint, it may be remarked that a few cases were considered to have developed a concealed internal hemorrhage from the signs of collapse and rapid pulse. Postmortem examinations did not substantiate this diagnosis. The clinical picture was undoubtedly due to the development of a fatal suppurative process.

GROUP II-A—*Operative Injuries and Traumatic Strictures of the Extrahepatic Bile Ducts*—Deaths attributable to duct injuries may be divided into the immediate and the remote. Three deaths occurred as a result of operative injuries to the ducts in the immediate postoperative period. In two of these, a cholecystectomy was performed after primary ligation of the cystic duct and vessels. The operation was relatively simple and the ducts were specifically described as being well visualized, and there was not the slightest suspicion that a serious injury had occurred. In the third, cholecystectomy was begun at the fundus in a very obese patient with an acute cholecystitis. The operation was difficult and complicated by hemorrhage. It was feared at the time that injury of the duct had occurred in an attempt to control the bleeding.

The hepatic duct was injured in all these cases, and in two there was simultaneous injury of its right branch. Anatomically no abnormalities were noted. In one instance, the ligature completely encircled the duct producing a picture of an increasing obstructive jaundice. In the other two cases the application of a lateral ligature to the duct wall produced a slough which permitted the escape of bile into the peritoneal cavity. This gave rise to a fulminating peritonitis, mainly subphrenic in distribution. While external tube drainage had been instituted in both these cases, there was no biliary drainage for a few days in one.

In addition to these three cases in which death occurred in the immediate postoperative phase, there were seven cases in which death was the eventual sequela of a previous operative injury to the duct. Two of these cases had their original operation performed at this institution and five elsewhere. A consideration of these cases in detail would take us too far afield. A few points, however, deserve mention.

Symptoms appeared within three months in three cases, within six months in three, and in five years in one case. There was a history of a biliary fistula which underwent spontaneous closure in four instances. The others had only transient biliary drainage. The duration of life following the onset of symptoms due to stricture was over four years in three (four, five and nine), and under one year in three. In the cases with a relatively long duration of symptoms a definite explanation was found at postmortem. In one, the stricture was only partial, the patient dying of suppurative cholangitis. In the

second, a spontaneous fistula had developed between the duodenum and right hepatic duct through which bile entered into the duodenum. The patient, however, developed biliary cirrhosis and died at the end of five years. One patient who lived for nine years had an external biliary fistula which opened and closed spontaneously. She finally died of hemorrhage into the duct system and externally following an attempt at dilatation of the sinus.

Three patients died within eight months after the onset of symptoms due to stricture. One died of suppurative cholangitis, and the other two of a complete biliary obstruction necessitating operation. One died from post-operative hemorrhage, and one died from peritonitis following a choledochoduodenostomy.

The site of the stricture was in the hepatic duct proximal to the entrance of the cystic in five cases, and in the common duct distal to the cystic in two. One of the latter was the result of an injury which occurred during a gastrectomy for duodenal ulcer.

In four instances biliary cirrhosis with splenomegaly was found. In two other cases there was a marked chronic cholangitis with periductal fibrosis.

These unfortunate deaths again emphasize the unrelaxing vigilance which must be maintained when approaching the region of the cystic duct and vessels. Morphologic variations are quite common and long standing inflammation further distorts the ordinary anatomic relationships. Retrograde cholecystectomy should commence with the exposure and visualization of the cystic duct. The cystic duct should be partially divided, probed and ligated before proceeding to ligate the cystic vessels. These should be secured at a point distal to the division of the cystic duct, and thus even farther away from the danger zone of Calot's triangle. Injuries to the hepatic duct seem to occur more commonly while securing the vessels than when dividing the cystic duct. The passage of ligatures on needles is especially dangerous. An aneurysm needle or a Deschamps' ligature carrier is much more likely to follow the normal planes of cleavage.

When removing a gallbladder from above downward, it is important to remember that the left or mesial aspect of the organ is much shorter than the right. Failure to remember this may bring the operator much nearer to the hepatic duct than he realizes, if his guiding points are the ampulla of the gallbladder and the free edge of the gastrohepatic ligament. In cases of acute gangrenous cholecystitis, undue traction must not be exerted upon the clamp holding the gallbladder, as the organ can be easily torn away at its junction with the cystic duct. It is probably wiser to leave a small area of the ampulla in gangrenous conditions because duct injuries are not so liable to occur in attempts to control hemorrhage.

The presence of a biliary cirrhosis giving rise to jaundice may lead to secondary operations when in fact the icterus is the result of the cirrhosis rather than obstruction from a reformed stricture.

*Wound Dehiscence and Evisceration*—These unwarranted complications were the primary cause of death in three cases, twice from the effects of a

pronounced ileus and once from a peritonitis. The operations were performed under inhalation anesthesia for chronic cholecystitis and cholelithiasis through an upper right rectus muscle splitting incision. In two instances the operator recorded excessive difficulties in effecting a closure of the abdominal wound. Symptoms of shock with abdominal distention and vomiting appeared within 48 hours in two cases. Acute dilatation of the stomach was suspected but it was not until the third day that the symptoms were explained by the appearance of an external evisceration. The stomach presented in the dehiscenced wound in two cases. In one instance a thrombosis of the gastric vessels and a severe ulcerative gastritis was present, probably as a result of an incarceration of the stomach in the wound.

In addition to these there were two cases in which evisceration was secondary to peritonitis with pronounced distention. It also occurred once following a violent coughing spell in a patient dying from suppurative cholangitis with liver and subphrenic abscesses.

As was noted above, the operations in which evisceration occurred, were all performed under general anesthesia. The greater ease and security of closure under spinal anesthesia should make this complication less common.

The symptoms of ileus should make one suspicious of a wound dehiscence, as paralytic ileus due to extensive small intestinal manipulations or mechanical intestinal obstruction is quite rare in gallbladder surgery.

*Pneumonia*—This was designated as a cause of death only when autopsy failed to reveal other significant lesions. If a postmortem examination, for example, disclosed either a cholangitis, a subphrenic abscess, or an ileus, and, in addition, evidences of pneumonia, the latter was disregarded as the determining factor in the fatal outcome. Pneumonia on this basis was responsible for 11 deaths, seven of 46 deaths following operations upon the gallbladder, and four of 31 in which the common duct was opened. Approximately one-sixth of the deaths following operation for inflammatory and calculus diseases of the biliary tract were thus due to acute pneumonitis. The factors predisposing to the fatal respiratory complications in this series might be listed as chronic bronchitis and a history of an old pleurisy each once, unusual obesity in two cases, and advanced age in two instances. The diagnoses were very evident clinically in all but two cases in which a fulminating pneumonia was not even suspected before postmortem.

The prevention of this complication still taxes the ingenuity of the profession. The present study shed but little light on its prophylaxis. The question of anesthesia in cholecystectomy is of great importance. Four of the seven inhalation anesthesia deaths occurred in an older age group, the three other patients were young, healthy and vigorous. All of the four patients in the spinal group were over 60, two being over 70. It is generally conceded that the type of anesthesia will probably have little effect on the incidence of pneumonia in older people. However, in this small group, it



would appear that spinal anesthesia in the young and vigorous is less apt to be followed by fatal pulmonary complications

All deaths following inhalation anesthesia were due to bronchopneumonia of various types and degrees. Necrotizing bronchitis with bronchopneumonia similar to the influenza type was present in a number of cases. Multiple abscess formation occurred in one case, a gangrenous pneumonitis in another and an empyema in a third.

The pneumonia following spinal anesthesia appeared to have a different pathogenesis for only one out of the four was of bronchopneumonic type. It was lobar in one case and in two the pneumonic process was engrafted upon a bilateral atelectasis involving both lower lobes. This atelectasis was possibly dependent upon the paresis of the diaphragm incident to spinal anesthesia. This may have been aided by the weight of the abdominal viscera pressing against this muscle while the patient was kept in shock position immediately postoperatively. It might be a better procedure to eliminate this position following spinal anesthesia unless it is distinctly indicated.

*Cardiac Failure and Pulmonary Embolism*—Three deaths were due to heart failure. Each exemplifies a type of problem with which the surgeon is confronted. The presence of cardiac damage was known in one, but this had to be disregarded in the face of extending infection. A simple cholecystostomy was performed under spinal anesthesia, progressive cyanosis and dyspnea followed, with death in 72 hours. Postmortem examination showed coronary arteriosclerosis with myocardial degeneration. In another, symptoms due to sudden cardiac decompensation with acute and chronic passive congestion of the liver were mistakenly interpreted as of gallbladder origin. The circulatory edema of the gallbladder was mistaken as inflammatory and a cholecystectomy was performed. The patient died of progressive heart failure. In the third the patient was abnormally obese but presented no preoperative evidence of organic heart disease. The heart, however, proved to be incapable of sustaining the increased burden necessitated by a cholecystectomy and choledochostomy for common duct stone. The postoperative course was afebrile and bile drained freely. There were a number of attacks of weakness with small pulse, which were thought to be due to either pulmonary embolus or cardiac failure. Sudden death occurred with signs of pulmonary edema of the lungs on the thirteenth day. Postmortem showed extensive myocardial degeneration and pulmonary edema. This latter type of death would probably be more frequent if very obese individuals were indiscriminately operated upon. It is now customary to refer these patients to the metabolic clinic for reduction. The fact that cardiovascular disease, especially closures of the coronary artery, may closely simulate attacks of biliary colic or even of acute cholecystitis must constantly be borne in mind. Whatever the arguments may be for immediate intervention in clear cut cases of acute cholecystitis, in doubtful cases of suspected organic heart disease the best interests of the patient will probably be served by a conservative attitude until the situation becomes clearer. On the other hand, the symp-

toms of patients with cholelithiasis and cholecystitis are often interpreted as being due to coronary artery disease, especially when minor electrocardiographic changes are present. The matter is still further complicated by the fact that both of these conditions frequently occur together. Here the co-operation of surgeon and internist in evaluating the importance of both symptoms is of the greatest moment.

Pulmonary embolus accounted for two deaths. In one of these there was a totally uneventful convalescence until sudden death occurred on the ninth postoperative day. In the other case there were two attacks of precordial pain and dyspnea, which were apparently interpreted as being of cardiac origin. On the fifteenth day there was sudden death from an embolus lodging in the main branch of the pulmonary artery.

TABLE III

## CAUSES OF DEATH IN INSTANCES OF CHRONIC CHOLECYSTITIS

Cause	Number
Peritonitis, diffuse	5
Retroperitoneal phlegmon	1
Duct injuries	2
Evisceration	3
Pneumonia	5
Pulmonary emboli	2
Enterocolitis	1
Intestinal obstruction due to stone	2
Sepsis	1
Cardiac	1
Pancreatitis	2
	—
	25

*Uremia and the "Hepatorenal Syndrome?"*—The cases which clinically manifested the uremic syndrome fall into two groups. In the first group, consisting of two patients, there was definite preoperative evidence of renal impairment, the postoperative course was characterized by an increasing azotemia, and the postmortem findings in the kidney were those associated with chronic nephritis and the arteriosclerotic kidney. In other words, this group consisted of patients whose diminished kidney function, due to definite anatomico-pathologic changes proved unequal to the increased burden thrown upon them by biliary infection and operation. It would be difficult to maintain that these pathologic changes were secondary to hepatic damage resulting from biliary tract disease. As a matter of fact, in one of these cases the disease was limited solely to the gallbladder, the ducts not being involved. Similar pathologic renal changes with a like postoperative course have been found in too wide a diversity of surgical conditions to permit of the view that the kidney alterations are specifically hepatic in nature.

In the second group were those cases which preoperatively showed no evidence of kidney disease but which following operation presented azotemia and clinically manifested symptoms resembling those of uremia. The symp-

toms encountered in this group have often been attributed to an "hepatorenal" syndrome. This group of ten cases may again be subdivided into those in which autopsy disclosed a definite anatomic cause for death, and those in which it did not. Seven cases fell into the former group, and in them either infective or suppurative processes sufficient to account for death were found. These were respectively (1) peritonitis, (2) diffuse confluent virulent bronchopneumonia, (3 and 4) suppurative pylephlebitis in two cases, (5) suppurative pancreatitis, (6) suppurative cholangitis, and (7) sepsis together with arsenic poisoning in the seventh case. In order to illustrate the manner in which clinical phenomena may be misinterpreted a very brief résumé of Cases 6 and 7 might be of interest.

Case 6 was that of a woman, age 30, who was operated upon for common duct stones and a virulent cholangitis. The temperature was normal after the first week. However, she always appeared somewhat shocked and her skin was cold and clammy. She received three transfusions with but little effect. During the third week postoperatively, the urine became bloody and scant, and there was a rise in the blood urea. She became irrational and died on the seventeenth postoperative day. Postmortem examination showed liver abscesses, subphrenic abscesses and a gangrenous cystitis, the latter finding explaining the hematuria.

Case 7 manifested the most classic clinical and pathologic evidences of hepatorenal insufficiency. Anuria supervened two days after the onset of symptoms and lasted for five days, with a steady rise in the blood urea to 180. The bilirubinemia simultaneously increased until the van den Beigh was 4.5 mg, and then receded concomitantly with a fall in the blood urea, and the secretion of urine. Finally both blood figures reached normal. The patient appeared to have been well on the way to spontaneous recovery when she developed a severe suppurative parotitis with a resultant *Staphylococcus aureus* sepsis. Autopsy disclosed a subsiding acute cholecystitis and cholangitis without common duct stones, hepatic degeneration with necrosis (the type found in bacteremia), and marked focal degenerative changes in the kidneys, bacterial in origin. This case might easily have been interpreted as a typical case of hepatorenal syndrome induced by an acute infection of the gallbladder. Two complicating factors in this instance were that arsenic was found in the urine on one occasion, and that a bacteremia was present which may have caused the pathologic changes in the liver and kidney present at postmortem. The significance of the arsenic is difficult to evaluate. It can produce a clinical picture simulating the above. The sepsis further complicates matters for the focal necrotic changes in the liver could be, and probably were, accounted for by bacterial metastasis.

It is obvious that in these seven cases the so called "uremic" picture was secondary.

Three cases, however, remained which presented, at autopsy, neither chronic nephritic changes nor any obvious cause for death. These patients were all over 55 years of age. The jaundice was not marked. The operative

findings were those of long standing disease apparently much longer than the history would indicate. The common and hepatic ducts were greatly distended and contained numerous stones but the obstruction remained incomplete. Their course following operation was characterized by sluggishness, asthenia, gradual deterioration, stupor and coma. The urinary output was diminished and the blood urea which rose to 105, 76 and 39 mg, respectively, in these three cases later fell to lower figures following the intravenous administration of sodium chloride and glucose. They did not, however, reach normal. It is important to note that there was no increased icterus paralleling the rise in the blood urea. Furthermore, the external drainage of bile continued freely in these cases. A phenomenon present in all these cases was a persistently low blood pressure which some thought was a factor in the production of the azotemia. Death ensued in 10, 14 and 60 days following operation, in the last case one month following a recrudescence of fever and reopening of a biliary fistula due to a retained stone in the common duct. Postmortem examination failed to reveal any marked or unusual degenerative changes in the liver in any of these cases. The changes in the kidney were not striking, and in one instance only were they enlarged as the result of the edema of the glandular and interstitial tissues.

However, it must be remembered that the clinical picture and azotemia present in the so called "hepatorenal syndrome" which occurred in the last mentioned three cases, are not confined solely to diseases of the biliary tract or liver. Extrarenal azotemia, with a similar clinical picture, is found in other surgical conditions such as traumatic shock, postoperative collapse, intestinal obstruction, extensive burns and some acute fulminating infections, especially those caused by the *Clostridium welchii*. Fishbein states that "the pathogenic circumstance common to all these states is a deficient venous return to the heart which is most often the result of a decrease in the circulating blood volume. The decrease in the venous return entails an equal diminution in cardiac output which probably reflexly causes peripheral vasoconstriction. The vasoconstriction includes the kidneys, and the consequent diminution in the renal blood flow results in azotemia which may be abetted by heightened destruction of protein with an attendant increase in the quantity of nitrogenous end products to be eliminated."

"LIVER SHOCK" DEATHS—In a discussion of the causes of death following gallbladder operations, the question of the so called "liver shock" deaths calls for consideration. These cases have been defined as those in which following a simple cholecystectomy there is a rapid development of hyperpyrexia with signs of either collapse or delirium, or stupor terminating usually in death within 48 hours. A clinical study of cases of this type has recently been reported in detail by Touroff, who used as a basis of investigation the cases of gallbladder diseases operated upon at The Mount Sinai Hospital during the past ten years. His conclusions are paralleled by those reached in this study of postmortem material. There were no instances of this clinical syndrome in which an autopsy failed to establish a well defined

anatomic cause of death. In all three cases the development of this high temperature syndrome led to a tentative clinical diagnosis of "liver shock" death. The following causes for death, however, were established by autopsy in these three instances: Case 1 Subphrenic peritonitis with beginning abscess formation due to *Streptococcus hemolyticus*. Case 2 Subphrenic and subhepatic biliary extravasation. Case 3 Fulminating, diffuse necrotizing bronchopneumonia of the influenza type.

There was another case similar to the above except that an incidental common duct stone was removed by choledochotomy. The patient was an obese woman of 60. The operation was prolonged, and during its course the colon was accidentally injured. *B. coli* and *B. Friedlander* were cultured from the gallbladder bile. There was no immediate shock but the temperature rapidly rose to 105.8° F with fatal issue in 18 hours. The only findings at autopsy were an acute gastric dilatation with erosions and degenerative changes in the liver. The findings were insufficient to account for the patient's death. However, it would seem that exitus was due to postoperative shock rather than a specific failure of the function of the liver.

GROUP II-B—*Primary Hepatic Degeneration (Subacute Yellow Atrophy)*—*Biliary Cirrhosis—Noncalculous Cholangitis*—Differential diagnosis between jaundice due to disease of the extrahepatic biliary ducts and that of intrahepatic origin is at times exceedingly difficult. There were seven instances in which failure to distinguish between the two led to the performance of futile operations. The surgical procedures, however, were not the causes of the mortality in five cases. These patients ultimately died from the uninterrupted progress of the disease from which they were originally suffering.

Autopsy unexpectedly revealed in three cases that death which followed cholecystogastrostomy for jaundice supposedly of an obstructive nature, was due to a primary hepatic degeneration, so called subacute yellow atrophy. These cases have been carefully reviewed with the idea of determining whether anything could have been done to have avoided these unnecessary operations. One point immediately became apparent, *viz.*, that all these cases clinically presented a constant or slightly increasing jaundice with the simultaneous presence of bile in the stool. This combination usually does not portray a surgical condition of the extrahepatic bile ducts. While it is conceivable that this combination of symptoms might occur either with a calculus cholangitis or a slowly growing carcinoma of the papilla, it certainly does not happen in cases of carcinoma of the head of the pancreas. The latter diagnosis was the one made at operation in all these cases by palpation of the pancreas and duodenum. In one instance the well known difficulty of pancreatic palpation was further complicated by the induration produced in the head of the viscus by the penetration of an ulcer of the posterior duodenal wall. But even here the operation of cholecystogastrostomy would probably have been avoided, had it been borne in mind that bile was present in the stool and urobilin in the urine. One of these patients became comatose two days following operation and died on the fourth day, and the other

two developed a septic type of temperature which led to the suspicion of subphrenic abscess. Autopsy revealed the classic picture of subacute yellow atrophy with degeneration. There were no abnormalities in the extrahepatic ducts and bile was found to be present in the common duct.

There were also two cases of biliary cirrhosis in which the operation was really exploratory in character. The presence of hepatic disease was recognized at operation which was limited in each instance to the performance of a biopsy and a cholecystostomy. One of these patients died within one week from hemorrhage. The other left the hospital and returned two years later to die from a gradual exacerbation of the disease.

In addition to the above cases, there were two cases of subacute cholangitis without fever and without stones in which surgical intervention was probably not indicated. Even after reviewing these cases it is difficult to see how these errors could well have been avoided. The history in both instances was typical of biliary colic, and while the patients had bile in the stool, the icterus on the other hand was only very slight. Operation in one instance was limited to an exploratory laparotomy, in the other a cholecystectomy and choledochostomy were performed. Judging from the autopsy findings these patients would probably have made a temporary, if not permanent recovery from their illness. Death in one instance was due to a peritonitis and in the other to a severe bronchopneumonia.

TABLE IV

CAUSES OF DEATH IN CASES OPERATED UPON WITH INCORRECT DIAGNOSES

Cause	Number
Biliary cirrhosis	2
Primary cholangitis	2
Subacute yellow atrophy	3
	—
	7

GROUP III—*Carcinoma of the Biliary Tract*—The mortality in this group has been extremely high. It has limited the radical surgical approach to neoplasms of the biliary tract until relatively recently. Operations have usually been confined either to exploration in order to rule out the possibility of calculi, or to palliative procedures. Lately the operative technic advocated by Whipple and Parsons in cases of carcinoma of the papillary region of the duodenum has stimulated new interest and hope in this field. This is partially warranted by the incidence of metastases found at postmortem in this and other reported series.

Operation was performed in four cases of carcinoma of the papilla. A transduodenal local excision of the tumor was performed in combination with a cholecystostomy in two of these. One of the patients died of a retroperitoneal phlegmon, the other from repeated intestinal hemorrhages. In the remaining two cases in which a cholecystogastrostomy was performed, the autopsy revealed that the neoplasm could have been removed by the

technic of Whipple and Parsons. Furthermore, no evidence of metastases was found in any of these four cases. In a recent nonoperated case of carcinoma of the papilla which died of suppurative cholangitis, no evidences of metastases were found.

Failure to recognize small carcinomata in the infraduodenal portion of the duct of pancreas may lead to perplexing difficulties following biliary tract operations. Fistulae or cholangitis may lead to multiple futile operations. Two such cases were finally solved at postmortem. A brief reconstruction of them might prove instructive. Cholelithiasis was absent and obstructive jaundice present in both cases at operation. A cholecystectomy with choledochal drainage was performed. The above combination of circumstances should certainly have contraindicated cholecystectomy as removal of the gallbladder enormously complicates the possibility of short circuiting the biliary flow above a possible obstruction developing subsequently. If, clinically, the jaundice has been obstructive and progressive, and at operation the duct appears dilated but thin walled, an incision should be made in the supraduodenal portion of the common duct as far from the junction of the cystic duct as possible. If exploration reveals no stone in the duct, the incision may be closed or drainage instituted. If a stricture or tumor is suspected, the duct may be ligated and divided and a cholecystogastrostomy performed. Judging from the findings in one of the cases, a specimen for pathologic examination could have been obtained from the distal portion of the choledochus by the use of a small curette. One further point merits mention. It is easily understandable that in the absence of positive evidence of carcinoma, one would be loath to proceed with a radical operation beyond a cholecystogastrostomy. Under these circumstances, the hope is assumed that the obstruction is due to chronic pancreatitis. It should be emphasized that in this postmortem series, chronic pancreatitis was never by itself the cause of sufficient encroachment upon the common duct to cause an obstructive jaundice of any severe degree.

The presence of an acute suppurative cholangitis without stones should arouse suspicions of an obstruction due to carcinoma low in the choledochus. Five such cases were encountered in this series.

Considerable differential diagnostic difficulty may be encountered in those cases in which a carcinoma of the duct develops at some period subsequent to the performance of a cholecystectomy. Three such cases were encountered at postmortem. The gallbladder had been removed six months, two years and nine years previously, respectively. The hepatic duct was the site of the lesion in all these cases.

Differentiation from an inflammatory lesion could have been made by the fact that the involvement of the duct was tubular, and extended for about one to one and one-half inches whereas an injury usually results in a narrowed annular stricture. Furthermore, the duct distal to the malignant obstruction could easily be traced to the site of constriction and without any loss of continuity. An accurate diagnosis may be obtained by removal of

a specimen. A similar difficulty may arise in which a chronic cholecystitis with stones is complicated by a stricture lesion in the common duct near the junction of the cystic duct. The strictures which were thought to be inflammatory in two such instances proved to be scirrhous carcinomata infiltrating along the cystic duct.

Carcinoma of the pancreas and gallbladder presenting symptoms which led to operation, were far less favorable surgically because of distant metastases. This difference is probably not occasioned by any variation in malignancy between these and duct carcinomata, but rather due to the lapse of time before symptoms became evident. Carcinoma of the ducts and papilla, because of the obstruction which they soon produce, inevitably give rise to jaundice early. Neoplasms of the gallbladder, and those tumors of the pancreas which do not originate in immediate juxtaposition to the duct, may remain silent for a considerable time during which widespread dissemination may occur. Postmortem examinations of operated cases of pancreatic carcinomata revealed widespread metastases to the regional lymph nodes and the liver in five instances. In two other cases in which no metastases were found, the carcinoma of the pancreas had developed adjacent to the common duct with early compression and invasion. A radical removal might have been feasible in these two cases had the pathology been recognized at operation.

Widespread metastases were found in seven of nine cases dying following operation for carcinoma of the gallbladder. In two cases without metastases, early operation had been forced in one instance by a pericholecystic abscess, and in the other by an infiltration of the common duct. Two patients had refused cholecystectomy for stone two years before their final and fatal operation and another had been subjected to an appendectomy for symptoms which were undoubtedly of gallbladder origin. The prognosis in carcinoma of the gallbladder would appear poor except in those cases fortunately operated upon for cholelithiasis in which a fundal carcinoma was incidentally removed.

TABLE V

CAUSES OF DEATH IN CASES OPERATED UPON WHICH HAD CARCINOMA

Cause	Number
Hemorrhage	9
Carcinoma and unrelieved jaundice	5
Suppurative cholangitis	5
Peritonitis	4
Duodenal fistula	1
Lobar pneumonia	1
Pulmonary embolus	1
Acute pancreatitis	1
Meningitis	1
	—
	28



**SUMMARY**—The causes of death in 130 autopsies occurring in surgical diseases of the biliary tract are analyzed. These are arbitrarily divided into three groups.

Group I comprises those upon whom postmortem examinations were performed, in which the disease process and its complications were found to be the eventual causes of death. Suppurative cholangitis accounted for death in 16 cases. This dreaded complication, the result of prolonged incomplete obstruction and low grade infection, ended either in multiple hepatic abscesses with or without perforation, portal or hepatic suppurative phlebitis, general sepsis or cholangitic hepatitis. The postmortem findings vividly represent the final result of years of operative delay, due either to lay ignorance or medical indifference to the excellent results derived from early surgical intervention. On the other hand, the importance of operative therapy in obstructive jaundice is, fortunately, fast being recognized. This is mirrored in the present study by the relatively few deaths from hemorrhage, only three, and the other manifestations of a prolonged obstructive jaundice, *i e*, death from the effects of an unrelieved jaundice and a biliary cirrhosis. The dangers inherent in a long standing biliary duct infection with "silent stones" (unfortunately not manifesting their presence by persistent clinical jaundice) have not as yet been sufficiently appreciated. This fact is reflected in this series by the high incidence of death due to cholangitic infection.

Suppurative pylephlebitis, the most fatal complication of a widespread and severe infection, was the cause of death in six cases of acute cholecystitis and in two cases of calculus cholangitis, and contributory in five cases. When once this complication, with its multiple pylephlebitic abscesses has developed, very little can be done, and death is invariably a foregone conclusion.

Diffuse peritonitis due either to perforation of the gallbladder into the free peritoneal cavity, a rupture of a pericholecystic abscess, or a "durchwanderung" infection complicating acute cholecystitis, accounted for nine deaths. This represents about one-third of the anatomic causes of death occurring in acute cholecystitis. However, the fact that this complication affected patients of advanced years is to be noted.

Group II-A is composed of the "interval" cases in which the disease at the time of operation was not threatening to life, and in which the lethal outcome could be traced either to errors in judgment or technic, or to those operative complications which at the present stage of surgical development seem to be almost unavoidable.

Diffuse peritonitis due to biliary extravasation, operative injury to viscera adjacent to the gallbladder or the exacerbation of a latent cholecystic infection, accounted for 13 deaths. Ten deaths were ascribed either directly to immediate operative injuries or subsequent traumatic strictures of the extrahepatic bile ducts. These fatalities, approximately 10 per cent of all deaths in benign cases, are a serious reflection upon surgery because they are directly attributable to technical mistakes which probably could have been avoided had greater operative care been exercised.

Wound dehiscence, an almost unwarranted complication, caused death in three cases. Hemorrhage due to technical failure to secure the cystic artery or control bleeding from the liver bed was not encountered in this series. Two deaths were due to uremia, with autopsy evidence of chronic nephritis (There were seven cases presenting a clinical picture resembling uremia in which definite extra-renal anatomic causes for death were found). Three cases presented a clinical picture resembling uremia but without definite renal changes evident at postmortem. These cases are frequently designated as hepatorenal insufficiency. They showed, however, no parallelism between the degree of jaundice and the diminution of renal function. Furthermore, neither extensive degenerative renal or hepatic changes were found at autopsy. Pneumonia, in spite of all efforts directed to its prophylaxis in recent years, accounted for 11 deaths, 11 per cent of the deaths coming to autopsy. Three deaths were due to heart failure, and two to pulmonary embolism. No cases of "liver shock" were encountered following cholecystectomy.

Group II-B is composed of autopsies obtained in those cases which were operated upon with a tentative diagnosis of gallbladder disease but in which neither operation nor postmortem findings verified the diagnosis. These cases consisted of subacute yellow atrophy of the liver, nonsuppurative cholangitis (cholangitis lenta), and biliary cirrhosis, and were undoubtedly confusing clinically. A more careful preoperative evaluation of symptoms and findings might have avoided a few unnecessary surgical mortalities.

Group III, comprising the carcinomata of the biliary tract, consists of 28 cases. Autopsy failed to disclose the presence of visible gross metastases in the majority of malignant lesions involving the papilla and extra-hepatic bile ducts. These findings emphasize the fact that these malignant lesions are worthy of an attempt at radical extirpation. The presence of fatal hemorrhage as a cause for death in these cases after a relatively minor surgical procedure emphasizes the wisdom of stage operations if the radical approach is contemplated.

#### DISCUSSION OF THE PAPERS OF DOCTORS HEYD AND COLP

DISCUSSION —HENRY W. CAVE, M.D. (New York), confined his discussion principally to Doctor Heyd's paper, which he considered a most painstaking and critical analysis of the author's experiences in 557 operations upon the gallbladder and extrahepatic biliary passages.

In a series of 500 noncomplicated cholecystectomies, he noted that Doctor Heyd reported a notably low mortality rate of 3.3 per cent, while in 34 cases of cholecystostomy for acute cholecystitis, there were five deaths, a mortality of 14.7 per cent. These mortality statistics appear in keeping with other similar series, in other hospitals, and again emphasize that too long delayed operation, with its accompanying occasional perforation and severe infection, adds to the death rate and demands drainage rather than removal of the gallbladder in this latter desperately sick group.

Regarding pulmonary complications, Doctor Cave stressed the fact that pneumonia, formerly feared and considered the most common postoperative complication, has to some extent been prevented by the use of avertin, nitrous

oxide, ethylene, or cyclopropane anesthetic combinations, ether seldom being necessary. Spinal anesthesia, he said, is not devoid of postoperative sequelae such as massive atelectasis and pneumonia. Hyperventilation of the lungs with carbon dioxide and oxygen at the close of the operation and at intervals for the following 24 hours tends to lower the incidence of pulmonary complications.

Hemorrhage at the time of operation, or immediately thereafter, may be caused by division of an anomalous vessel or from a friable cystic artery which may be cut through by the ligature, or, thirdly, from injury of the portal vein or the hepatic artery in an attempt to clamp the cystic artery which may have slipped away. Finally, there may be profuse bleeding from the gallbladder sulcus. The transfusion of whole blood prior to, and immediately after, operation will diminish uncontrolled capillary bleeding in patients with severe obstructive jaundice and is far superior to the use, in whatever amounts, of calcium lactate.

Accurate anatomic dissection with proper exposure through a sufficiently long incision, the removal of the gallbladder from above downward, with identification and separate ligation of the cystic artery before the cystic duct is clamped or tied, leaving a flange of the serosal surface of the gallbladder wall to close over the gallbladder sulcus, will not only diminish considerably the danger of hemorrhage but the danger from kinking and injury to the common bile duct.

Holman has demonstrated that anomalous branches of the hepatic ducts not only may be present, but if cut, during the course of a cholecystectomy, may be the source of an immediate and, at times, prolonged and distressing biliary drainage; moreover, small biliary passages may be opened, especially if much liver tissue has been traumatized. These two facts alone, he thought, are of sufficient importance to demand drainage after all cholecystectomy operations, thus practically doing away with that infrequent yet possible death from bile peritonitis. Although he had closed 20 per cent of his cholecystectomy cases, without drainage, without a fatality, he nevertheless was convinced that drainage should be instituted in all fairness to the patient.

Concerning that enigma, "liver deaths," about which there is very little substantial knowledge, Doctor Cave recalled three deaths within 40 hours following cholecystectomy, reported from Roosevelt Hospital in 1926. These were classified as so called "liver deaths" and it was believed that these fatalities were due to absorption of toxins from chemically impaired liver cells or infected bile from the intrahepatic biliary passages. Whatever the actual cause of death in this baffling group of patients, he felt that with the abundant use of sugar by mouth and glucose intravenously before and after operation, these unfortunate catastrophes might be eliminated.

Infection of the lesser peritoneal cavity in the cases of acutely inflamed gallbladder can be avoided by the use of a folded gauze Mikulicz pad placed snugly in the foramen of Winslow, as suggested by Lahey.

Incisional hernia, which occurs all too frequently, must be considered a late complication of gallbladder surgery. It is especially prone to follow drained, acutely inflamed gallbladder cases or prolonged drainage of the common duct, but stab wound drainage in the flank also occasionally results in herniation. In a series of follow up notes on 100 operated cases of gallbladder disease at the Roosevelt Hospital, surveyed recently, the amazing discovery was made that there were 12 incisional herniae, all of which had occurred in cases where catgut had been used, and he wished to be emphatic in stating that the use of silk throughout in right upper quadrant wounds in the nongrossly infected cases is important if the incidence of incisional hernia is to be diminished.

DR ALLEN O WHIPPLE (New York) remarked that one seldom had the opportunity to review such a large number of autopsy studies, in an individual group, as had been presented by Doctor Colp. Autopsy records are always enlightening in that they point unmistakable lessons. In going over the various causes of death in these cases, certain factors stood out. In regard to biliary peritonitis, however, one exceedingly important point was not mentioned. He had learned a lesson from a rather serious peritonitis that had resulted from a mistake, the possibility of which is not mentioned in either text-books or articles, namely, the tendency in the operating room, after the common duct drain has been inserted and sutured onto the common duct, and the drain brought out, to clamp off the tube so that it will not soil the dressings. The patient is then sent down to the ward, and unless very definite instructions are left to have the clamp removed immediately, so that the bile flow may be restored, there is excellent chance of bile leakage, sometimes of a very infectious character, into the peritoneal cavity, during the first ensuing two or three hours. In one of the three cases at Presbyterian Hospital where this occurred, fatal peritonitis developed. The intern staff, in fact all of the staff, should be impressed with the urgency of not having the common duct drain clamped off when the patient is taken down from the operating room.

In regard to common duct structure, Doctor Whipple emphasized one point particularly, namely, when an anomaly is found either in the vessels or in the ducts, the greatest care should be exercised to avoid damage to other anomalous structures. He had only a few days previously operated upon a patient with an aberrant hepatic artery running anterior to the common duct, that is, there was an anomalous duct system as well as the anomalous vascular system. Doctor Whipple stressed the fact that if a duct has been injured, the time to repair it is *immediately*. The repair, if done at the time of injury, is incomparably easier and the results infinitely better, particularly if the duct has been cut.

Regarding the possibility of carcinoma of the papilla of Vater being present in cases of deep jaundice not associated with stone, he particularly concurred in Doctor Colp's emphasis of the diagnosis of carcinoma where there is no associated stone. He also stressed the fact that no attempt should be made to remove a carcinoma of the papilla in one stage. These patients will not stand an extensive operation when they are deeply jaundiced, and if any attempt is made to excise the tumor through the duodenum there is very great risk of hemorrhage or of duodenal fistula because of the failure of tissues to unite properly with the patient in the condition he is in at that time. The operation, if it must be performed, should be carried out in two stages, and it is most essential to make a large opening between the gallbladder and the stomach if the operation is done in two stages with the idea of resecting the duodenum. The only late unfavorable result in Doctor Whipple's experience had been the tendency for cholangitis to occur because of the narrowing of the opening between the gallbladder and the stomach. Therefore, the opening must be sufficiently large to avoid cholangitis.

DR HENRY F GRAHAM (Brooklyn, N. Y.) reviewed the causes of death in gallbladder inflammations and stated that careful analysis would show that practically all are due to delay, assuming competent surgical care. This delay is threefold: (1) On the part of individuals affected, (2) the medical profession, including the gastro-enterologists, and (3) on the part of surgeons after the patient has entered the hospital.

The surgeon's policy of watchful waiting has encouraged the entire medi-

cal profession to believe that to watch and delay operation in cases of acute cholecystitis is all right. They reason, logically, that the patient might just as well be watched at home as in the hospital. Goldish and Gillespie have shown that the average age of those who died after operation was ten years more than that of those who lived, which is an indication, at least, that their disease had lasted longer.

Touraff reported 75 cases of proven acute cholecystitis from Mt Sinai Hospital that had been operated upon during the "resting" period following an acute attack. In 24 cases—or nearly one-third—pus or gangrene was present at the time of operation—a poor advertisement for watchful waiting. Repeated attacks of pain and vomiting cause inanition, diminished resistance to infection, and a feeble heart muscle. Liver function is inhibited or destroyed.

An analysis of the last ten deaths in 135 cases (66 per cent mortality) on the speaker's service at the Methodist Hospital showed that the common duct had to be drained in five, or 50 per cent of cases. In four, stones were present in the common duct. There were one perforated, three gangrenous, and one suppurative gallbladder, and one abscess outside the gallbladder with a concomitant pancreatitis. Delay was evident in all of these. There was only *one* death from *pneumonia*—in a case of gangrenous gallbladder, and there was one cardiac thrombus, also with a gangrenous gallbladder.

Doctor Graham cited one case in particular to illustrate the danger of delay. This man had suffered pain for four months before coming to the hospital, had lost 30 pounds in weight, and had had repeated attacks of jaundice. A contracted gallbladder containing stones was removed, the common duct explored, and the wound drained. Inanition continued. One month after operation the wound burst open and he died 24 hours later. Autopsies on two other cases showed multiple abscesses with a pelvic abscess in each instance, while a third case showed an area of liver necrosis near the gallbladder bed.

The speaker wished to make a strong plea for a crusade to urge prompt operation in an early attack of cholecystitis, prompt reference of cases of acute cholecystitis or exacerbations of chronic cholecystitis to the surgeon, and prompt operation by the surgeon. Prompt operation implied education of the general public, the profession and the gastro-enterologists. He had recently removed a gallbladder two weeks after a woman had given birth to a baby. More than 100 stones were present. Yet her first attack had occurred four months before the operation! If such a campaign were initiated, it would unquestionably result in a marked improvement in gallbladder mortality.

DR GEORGE J HEUER (New York) had recently been studying cases of acute cholecystitis at the New York Hospital, and thought it seemed advisable to consider the disease as a specific condition in the sense that it should not be included in the general run of gallbladder cases, and to determine whether the prevailing opinion that it was wise to wait for the acute attack to subside before subjecting the patient to operation was justified by the results obtained. A study of the cases of acute cholecystitis at the Cincinnati General Hospital showed (1) That it is often impossible from the symptoms, physical signs and laboratory data to predict the course of the pathologic process in the gallbladder. The attack may subside, it may proceed to gangrene and perforation of the gallbladder even in the presence of subsiding symptoms, (2) That if acute cholecystitis is considered as a disease by itself, the incidence of gangrene and perforation is quite high and occurs in about 20 per cent of the cases, (3) The mortality following operation in-

creases greatly as a result of gangrene and perforation, and represents from 10 to 20 per cent of the total mortality in the general run of gallbladder cases. In Doctor Colp's series at Mt Sinai Hospital it represented 33 per cent. This situation suggests that encountered of acute appendicitis, a disease which for some time was considered safer to treat surgically in an "interval," *i e*, after the acute attack has subsided.

A further study of 126 cases of acute cholecystitis at the New York Hospital leads to findings, in general, similar to those in Cincinnati. In 125 cases, 32 or 25 per cent had at operation gangrene or gangrene and perforation of the gallbladder. Our attitude toward operation in this series of cases was to operate earlier in the disease in order to prevent the mortality due to gangrene and perforation. In over 65 per cent of the cases, therefore, operation was performed the day of admission. The results show that in 125 cases there were four deaths, an operative mortality of 3.2 per cent. Analyzed from the viewpoint of the extent of the disease, there were 112 cases of acute cholecystitis without demonstrable perforation of the gallbladder with two deaths, a mortality of 1.8 per cent, and 13 cases with perforation of the gallbladder, extrahepatic abscess (12) and generalized peritonitis (1) with two deaths, a mortality of 15.3 per cent. From these observations it would appear that the dangers of operation in the acute stage of acute cholecystitis have been overemphasized and that operation before gangrene and perforation have occurred is helpful in reducing the mortality in acute cholecystitis.

DR HOWARD LILIENTHAL (New York) recalled that 32 years ago he was the first one in America to publish a series of gallbladder operations. There were 42 cases of cholecystectomy, unselected, one of whom was a woman six months pregnant and suffering from acute Streptococcic sepsis. This case was the only mortality (2.3 per cent—an unusually fine record even now). He developed a method at the time which came to be known by his name, and asked Doctor Colp if he would not state, in closing, whether it is still being used, *i e*, the gallbladder is dissected free until the neck is reached, then two sutures of chromicized catgut are put round the neck of the gallbladder, but not tied, they are used as traction ligatures to cut off the gallbladder without constricting it. Utilization of this method makes it possible to see exactly what bleeds and to care for it. The gallbladder bridge was at first used, now the broken table. Sometimes bleeding is noted after the angulation of the table has been straightened. If so, it should be raised again and the vessel caught.

With regard to pylephlebotic abscess, which Doctor Cave intimated to be a hopeless condition, Doctor Lilienthal felt that although it is generally hopeless, nevertheless it is not completely so. He reviewed a case he reported before the New York Surgical Society a good many years ago, a patient upon whom he operated for an acute condition of the gallbladder accompanied by stones, and in whom he found several fairly good sized hepatic abscesses, *i e*, the size of a small English walnut. He opened four or five of them, but did not make any attempt to do more. He thought the man would die, but, on the contrary, not only did he get well but he returned a year later to have his gallbladder removed. This was effected and the scar of one of the abscesses that had been incised at the first operation was resected, which, when examined, was found to consist of bile pigment and fibrous tissue. There were multiple healed abscesses at that time. In any similar case that he might encounter, he said he would not say, "This patient has to die," but would open as many of the abscesses as he could, and hope for recovery.

# SURGICAL ASPECTS OF ADENOMA OF THE LIVER

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ADENOMA of the liver may attract attention on account of the presence of a mass in the upper abdomen. It may remain silent for a long time, or so interfere with the function of neighboring organs by pressure or displacement, especially upon biliary channels or vessels, as to cause clinical symptoms. Occasionally an adenoma is discovered in the course of an upper abdominal exploration or it may be found at postmortem. The ability of the liver to compensate functional disturbances explains the absence of symptoms for long periods.

Adenoma of the liver occurs at all ages. The finding of an adenoma in young infants or nurslings suggests the congenital origin of these tumors, and such terms as "dysembryomata" and "malignant embryonal adenoma" of nurslings seem, therefore, quite appropriate. The congenital origin of adenoma of the liver is supported by various reports from the literature. Pepere<sup>20</sup> described malignant embryonal adenoma in nurslings. Wagner<sup>28</sup> found several nodules of liver tissue in the falciform ligament in two infants. Rolleston<sup>22</sup> found, on several occasions, minute liver lobes, which he considered congenital hepatic inclusions or rests. He believes that these segments may have been separated during fetal life from the main liver and that they subsequently became embedded into the liver. Christian found multiple nodules under Glisson's capsule. Pepere reported an adenoma of the liver proper and many small adenomata scattered over the peritoneum and omentum. Milne<sup>18</sup> reported an adenoma three inches in diameter in a child six months old. Hippel<sup>12</sup> found an adenoma in the left lobe of the liver in a girl one and three-quarters years old. Wegelin<sup>29</sup> encountered a primary adenoma of the liver in a boy five and one-half years old, with metastases in both liver and lungs, and reported three other adenomata found in the suspensory ligament of the liver in a man 72 years old. Kauffman has also described several cases of adenoma in people over 70 years of age.

The views concerning the origin and development of adenomatous masses in and about the liver may be grouped as follows:

(A) Congenital origin (Rolleston, Christian, Pepere, Milne, *etc*), due to hepatic inclusion in embryonal life or pedunculation.

(B) Mechanical segmentation of liver tissue by tight lacing, belts, *etc*. Continuous pedunculation of a segment of liver may hang by a long pedicle from the liver proper as shown in the Anatomic Museum of Cambridge. Chaillous<sup>5</sup> found several large accessory lobes of liver attached to the lower border of the liver close to the falciform ligament. A specimen in St George's Hospital museum shows the left lobe of the liver separated from



the right lobe by a distance of three inches and connected by a pedicle. Several cases have been reported in which accessory lobes were entirely separated from the liver proper and were attached to the gallbladder.

(C) Nodular, compensatory hyperplasia. Destruction of liver tissue by cirrhosis, sepsis, malaria, poisons of various kinds develops hyperplastic nodes of adenomatous tissue, a reparative phenomenon.

(D) From adrenal rests (de Vecchi, Schmorl, Beer, Oberndorfer), C. V. Weller<sup>30</sup> describes misplacement of an entire adrenal under the capsule of the liver. Ramsey<sup>21</sup> describes a malignant hypernephroma of the liver in a man of 57, the tumor "originating from embryonal adrenal rests in the liver." Stoerk and Wilson and Willis expressed their doubts about real hepatic hypernephroma. Rolleston comments on this controversy as follows: "but, just as in the case of renal hypernephroma, so in the case of hepatic hypernephromas doubt must be faced as to the adrenal origin." However, the reverse situation seems to have been encountered by T. S. Cullen,<sup>6</sup> who describes and illustrates several nodules of liver tissue embedded in the adrenal.

*Pathology*—Adenoma of the liver may be small or large, single or multiple, encapsulated, yellowish-brown or yellowish-red, either soft or hard. The size of the tumor may vary from small cherry sized nodules to that of a grapefruit or larger. Lecene<sup>15</sup> reported an adenoma the size of two fists. Muir reported a liver cell adenoma in a girl of nine measuring 4×3×3 inches. Milne's case occurred in a child six months old and was three inches in diameter. Keen recorded a case 9×6 cm. Chaher and Martin<sup>4</sup> described a trabeculovesicular adenoma with secondary hemorrhages and malignant degeneration, the size of a fetal head. Rolleston believes, as stated before, that all these large adenomata are merely hepatic segments separated during embryonic life, with subsequent development.

Adenoma of the liver may be classified according to the origin or histologic pattern as follows:

Aschof

- (1) Liver cell adenoma (Rokitansky adenoma, acinous adenoma)
- (2) Bile duct adenoma (tubular adenoma)

Gasparian<sup>10</sup>

- (1) Hepatocellular
- (2) Cholangiocellular

Rolleston classifies adenoma into

- (1) Benign adenoma, or dysembryoma
- (2) Trabecular adenoma with malignant tendency, alluded to as hepatoma (Sabourin)

He further classifies adenomata as originating from

- (a) Liver cells (acinous adenoma)
- (b) Bile ducts
- (c) Inclusion of adrenal rests



The hepatocellular adenoma is usually single, light brown, reddish or grayish-white, soft and encapsulated. It mimics the pattern of the liver lobule. The strands of polyhedral cells, however, are not regularly arranged around a central vein like in the normal hepatic lobule. The cells are larger, often containing fat, and may secrete bile, there is present a network of capillaries and convoluted liver cells.

The acinous type may be transformed into the tubular type if bile secretion takes place and if there is a central disintegration of the tumor, or if hemorrhage takes place. These evolutionary changes may go beyond this stage and form a cystic adenoma.

The bile duct adenoma (tubular adenoma) is grayish, on account of the richness of connective tissue. It consists of woven strands of cells resembling bile ducts. The cells are columnar, and according to Gasparian<sup>10</sup> they occur most commonly in men of advanced age. The epithelium of these cells may become ciliated, as was the case in the tissue studied by Cagnetto.<sup>3</sup> These adenomata belong to the functioning types of tumors. According to Rolleston, bile duct adenoma has a tendency of indenting and displacing, but not invading, the surrounding liver substance.

Adenoma of the liver is considered by some a reparative phenomenon in cirrhosis of the liver, as well as other destructive processes, such as malaria, venous engorgement, and sepsis (Yamasaki). In experimental blastomycosis in guinea-pigs, liver destruction is followed by multiple, encapsulated areas of hyperplasia. Supranumerary lobes are often found in cirrhosis of the liver. Regenerated liver substance forms small, pale nodules difficult to differentiate from adenoma. The lack of encapsulation of these nodules classifies them as distinctly cirrhotic in origin (Heller<sup>13</sup>). Caminiti<sup>2</sup> reported 22 cases of solitary adenoma, four of which showed cirrhosis. Gutiérrez and Mousérat<sup>11</sup> found rich, new growing bile ducts in a cirrhotic node. Likewise, Marchand and Ciechanowsky and others found in these hyperplastic nodes, inter- as well as intracellular biliary capillaries. Thole<sup>20</sup> and Rosenstrisch<sup>23</sup> cite many cases of cirrhosis without the presence of adenoma, and several cases of adenoma without cirrhosis. The articles of these two writers dwell at length upon this controversy. Kietz<sup>14</sup> states that adenoma and adenocarcinoma are exceptionally found in noncirrhotic livers.

Adenoma is subject to many structural changes. A common occurrence is cystic degeneration, usually due to hemorrhage or bile secretion. Leppman<sup>16</sup> collected nine cases of adenoma with cystic changes. Shattuck's<sup>25</sup> case of cystic adenoma contained four quarts of yellow fluid. The histopathology differentiated this cyst from what may have been termed "simple cyst of the liver." Some of these cystic adenomata may undergo papillomatous changes. Adenoma may undergo fatty changes, be the seat of hemorrhage, soften, and occasionally cause portal thrombosis. Transitional forms from hyperplasia to adenoma and from adenoma to carcinoma have been described by Grawitz. Adenomata are usually pure tumors of one type or another, yet in the case of Hippel,<sup>12</sup> a girl of 21, there was a mixed tumor.

showing adenomatous tissue, cartilage, and keratosing pavement epithelium and pigment

The malignant potentiality is emphasized by most writers, especially in those people with a "cancerous constitution." Heller<sup>13</sup> states that it is often quite difficult to differentiate adenoma from carcinoma, both grossly and microscopically. Perls<sup>19</sup> and Greenfield<sup>9</sup> were among the first to observe metastases from adenoma of the liver, although they do not consider this phenomenon a final proof of a cancerous nature of adenoma. In order to determine the malignant character of adenoma, serial sections must be made through the entire tumor. Gasparian<sup>10</sup> discusses the case of an adenoma in which portions of the tumor looked like hypernephroma, while the others looked like adenoma.

The diagnosis and differential diagnosis of adenoma of the liver have a wider range than one might suspect. In the first place, if the adenomatous mass is palpable, one has to distinguish it from other tumors in the upper abdominal quadrant. Tumors of the liver proper, such as angioma, cavernoma, lymphangioma, myoma, teratoma, embryoma, as well as other rare benign tumors of the liver, are difficult to diagnose before operation, and as such, their identification is merely conjectural. Ascoli,<sup>1</sup> analyzing the histories of 16 patients admitted to the Clinica Chirurgica of Rome with the diagnosis of primary tumor of the liver, found that two were gummata, four sarcomata, six epitheliomata, one lymphangio-endothelioma, and one cavernoma. If the cystic adenoma becomes large and is dragged downward, it may be confused with an ovarian cyst. Cystic tumors, such as echinococcus cysts or cyst adenoma, may be suspected by their softer consistency, larger size, and in the case of the former, the diagnosis can be established by the complement fixation test, while in the case of the latter, it can be suspected by the association with cysts in other organs, as well as a familial tendency. Hemangioma (cavernoma, nevus) may be simple or multiple, associated with vascular tumors elsewhere, but as a rule is discovered at autopsy. These tumors may grow slowly and attain a large size. A vascular tumor, reported by Major, Black and Donald,<sup>17</sup> first noticed in a patient age 16, ended fatally 18 years later when it weighed 40 pounds. Rubin<sup>24</sup> reported a huge, pedunculated hemangioma gravitating into the pelvis and interfering with a pregnant uterus. The tumor was successfully removed.

Solitary tubercles may attain large size and simulate a tumor. During exploration or postmortem examination, small, typical tubercles will always be found in the vicinity of the larger tubercle. Finkelstein<sup>8</sup> reports a case of tuberculoma, the size of a man's fist, the removal of which required partial resection of the liver.

Gumma of the liver is often mistaken for adenoma and vice versa. According to Kauffman, gummata are not found deep in the liver substance and their seat of predilection is in the suspensory ligament or hilus. Gummata are notorious for their mimicry of many pathologic processes. Gummata are single or multiple, project beyond the surface of the liver, are

globular or irregular in shape. They are usually grayish-white on the surface and yellow on section. The Wassermann reaction is often negative, in fact much more frequently negative than in other types of visceral lues (McCrae and Craven). The spleen is often enlarged and there may be slight fever present. The therapeutic test is of value. There is frequently evidence of perihepatitis on the convexity of the liver.

An accurate diagnosis of adenoma of the liver is in most cases a mere guess. All a careful diagnostician can be expected to establish is the presence of a tumor in and about the liver. Pneumoperitoneum, cholecystography, and other types of roentgenologic examination may be of some help.

The symptomatology of adenoma of the liver offers nothing pathognomonic. Biliary and hepatic symptoms may be due to compression of the gallbladder, biliary channels, or neighboring blood vessels. The ability of the liver to compensate hepatic interference explains the clinical silence of these tumors, which are often discovered accidentally. The position and anatomic relation of these tumors explain pain in the back, shoulders, dyspeptic, intestinal and even urinary symptoms, depending upon whether the tumor compresses the gallbladder, duodenum, stomach, or the right kidney. An adenoma of the left lobe of the liver over the stomach may simulate a pancreatic cyst. The case of Fischer<sup>7</sup> suggested appendicitis. The patient, a young woman 24 years old, complained of dull ache in the right hypochondrium with paroxysms of pain associated with a slight rise in temperature. Operation revealed a tumor between the two lobes of the liver, adherent to the large intestine, peritoneum and gallbladder. If adenoma is associated with cirrhosis, the cirrhotic complex may be the conspicuous feature in the case. Softening of the tumor and invasion of a neighboring vein may present the picture of portal thrombosis. Adenoma of the liver must be differentiated from wandering liver and pancreatic tumors. All such tumors are apt to give rise to sudden symptoms on account of the twisting of their pedicle.

If one is able to establish, with reasonable accuracy, the presence of a tumor of the liver, the chief concern of the diagnostician is whether or not the tumor is malignant, particularly since the malignant potentialities, and even occasional metastases, of adenoma are well known. In this differentiation, sarcoma of the liver must also be considered. This tumor occurs most frequently in children, grows rapidly, is associated with scanty urine, ascites, and icterus.

Extrinsic pressure upon the pylorus may suggest pyloric obstruction. Adams obtained prompt relief of pyloric obstruction by removing an adenoma which pressed upon the pylorus. In our case the most conspicuous symptoms were urinary manifestations, because the tumor pressed upon the pelvis of the right kidney and upper ureter; these symptoms disappeared promptly after the removal of the adenoma. Newman relieved an hydronephrotic complex by removing a "wandering liver."

**Case Report**—Miss M, age 24, white, clerk During the past year the patient had been conscious of a sense of fulness in the right hypochondrium, never amounting to actual pain There was, however, occasional pain in the region of the right scapula and the right lumbar region, either independent of, or referred from, the right hypochondrium About six months ago frequency and difficulty in urination were noticed from time to time The patient was otherwise in excellent health and had not lost weight Her appetite was good There was no nausea, vomiting, belching, or any other dyspeptic symptoms Bowel movements were normal There were no nervous manifestations, nor was fever present at any time Menstrual history, essentially negative Past illnesses—negative Family history—negative

**Physical Examination**—Patient was a young woman, of short stature, to all appearances in excellent health Skin showed no scars or other dermal lesions There

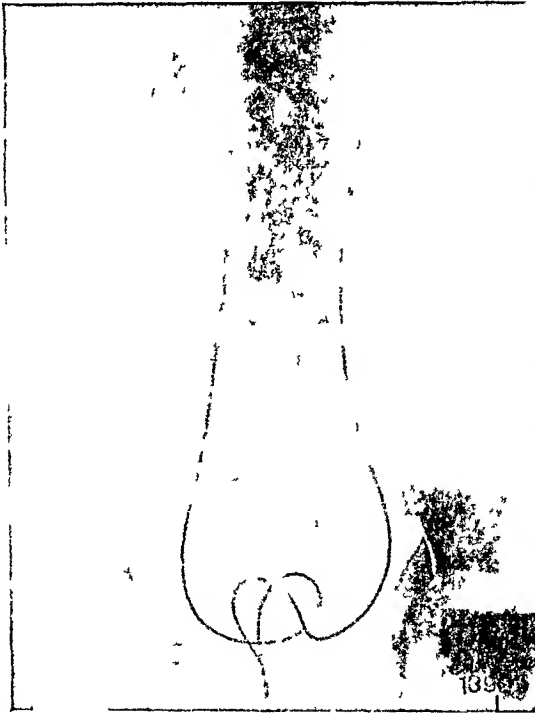


FIG 1—Right catheter does not go as far as the left, suggesting obstruction



FIG 2—Right distended pelvis with ill defined calices

was no adenopathy Reflexes, cutaneous, muscular, and tendinous, were all normal Lungs normal Heart normal in size, no adventitious sounds Examination of the abdomen revealed a palpable mass below the right costal arch, in the region of the umbilical fissure The inner, outer, and lower aspects of the tumor were appreciable, the upper border, however, was not definable It was about the size of a small grapefruit It was slightly painful to pressure and could be easily pushed toward the right kidney fossa Bimanual palpation did not suggest that the mass was connected with the right kidney, as the posterior hand could be pushed into the kidney fossa without feeling the tumor in front

**Röntgenologic examination** revealed an indefinite shadow below the right costal arch, but the roentgenologist would not commit himself to an exact diagnosis

**Laboratory Data**—W B C 9,200 R B C 4,250,000 Hb 75 per cent Wassermann negative Urinalysis negative

On account of the frequency and painful micturation and our inability to establish the anatomic location of the tumor, a cystoscopic examination was made with the idea

that it might reveal a kidney tumor which projected itself forward. It demonstrated that the ureteral catheter did not go up as far on the right side as it did on the left (Fig 1), and suggested obstruction. Roentgenogram after skiodan injection showed the right pelvis larger than the left and that the calices were ill defined (Fig 2). Both the urologist and the roentgenologist agreed that there was a distended pelvis, with poorly defined calices on the right side, apparently due to a moderate obstruction of the upper ureter on the same side.

*Operation*—The usual kidney incision was made and the right kidney readily exposed. It was found to be normal in every respect and its pelvis likewise normal in contour, shape and size. Palpation of the upper portion of the ureter was negative. A mass could be easily felt projecting from the peritoneal cavity, contiguous with the pelvis of the kidney, and we soon appreciated that we were in error and were dealing with an intraperitoneal mass. The wound was closed and a pararectus upper abdominal incision made. Upon opening the peritoneum, a mass appeared in the region of the umbilical fissure and portal orifice of the liver. The tumor was attached to the lower edge of the liver in close relation to the suspensory ligament. It extended equally to-



FIG 3—Gross appearance of tumor

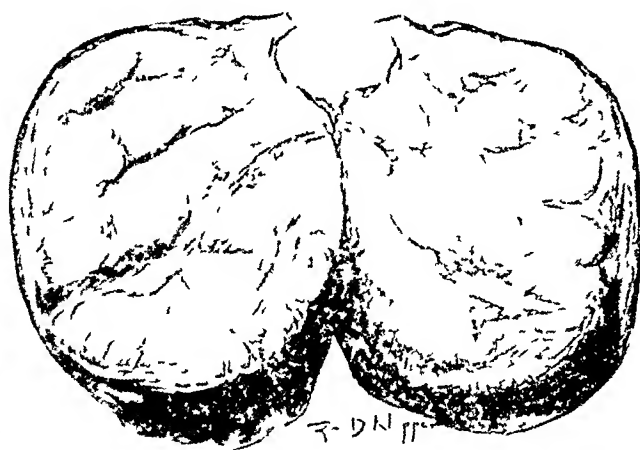


FIG 4—Gross appearance of tumor after bisection

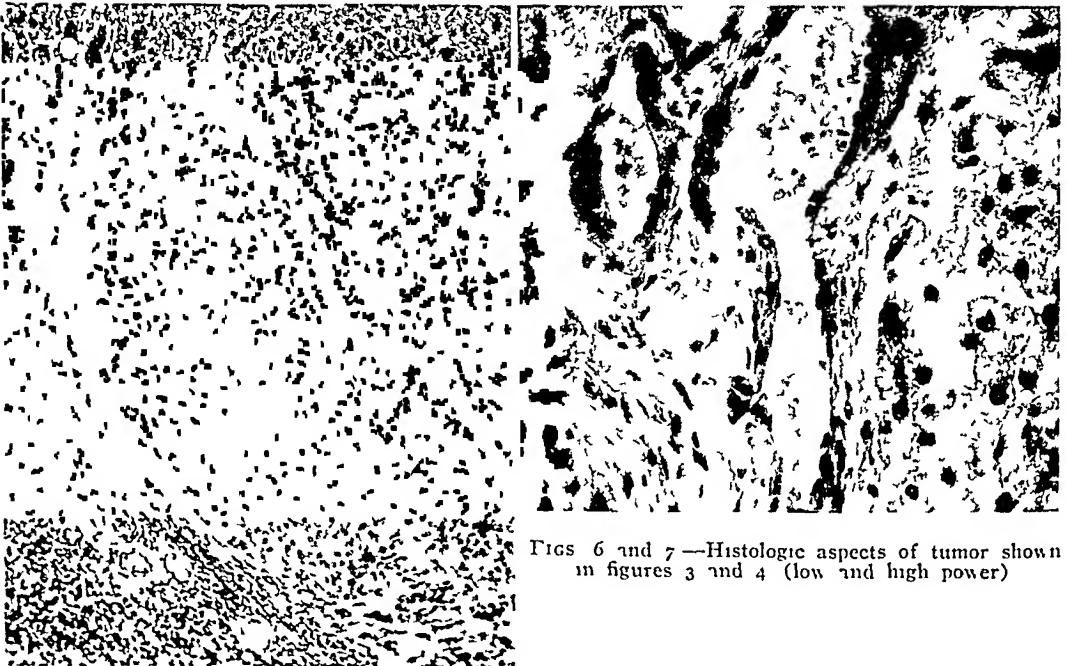
ward both lobes, and was the size of a small grapefruit. It was reddish-brown in color and resembled liver tissue. The mass was somewhat lobulated and was loosely attached to the omentum (Figs 3, 4 and 5). A wedge shaped incision was made into the liver substance, freeing the tumor from its attachment. The defect thus made was closed with plain catgut No 2 sutures, taking a deep bite into the liver about three-quarters of an inch from the liver defect. There was very little bleeding present and hemostasis seemed to be effected. The abdomen was closed. The patient made an uneventful recovery, and both wounds healed without suppuration.

All previous symptoms, especially the urinary symptoms, disappeared promptly after operation. Relating the experience in this case to a well known urologist. He made a sharp distinction between a dilatable and a dilated pelvis of the kidney. A pelvis may be dilatable by extrinsic pressure, even giving rise to clinical symptoms, which, however, subside when this pressure is removed, and the pelvis returns to normal. A dilated pelvis, on the other hand, is consequent to some obstruction and remains dilated even after the obstruction is removed.

Through the courtesy of Dr. Richard Jaffé we are enabled to report a second case of adenoma of the liver which was discovered at postmortem on a fatal case of ruptured ectopic pregnancy.



FIG 5—Relation of tumor to neighboring viscera



FIGS 6 and 7—Histologic aspects of tumor shown in figures 3 and 4 (low and high power)

## ADENOMA OF THE LIVER

**Case Report**—The patient, a colored girl, age 31, weighing 216 pounds, admitted with an acute abdomen. Diagnosis: Hemorrhage into the peritoneal cavity.

**Autopsy** by Dr. R. H. Jaffe revealed a ruptured ectopic pregnancy of the right tube with extensive intra-abdominal hemorrhage. The minutia of this autopsy are omitted, except the findings in the liver. The liver weighed 1,590 Gm and was of lessened consistency. On its surface were spherical areas from 1 to 11 Mm in diameter. In the center of the left lobe there was a firm, lobulated mass which bulged over the



FIG. 8—Autopsy specimen showing cut surface of tumor in left lobe of the liver.

superior and especially the inferior surface of the liver. It measured 10×8×8 cm. It was light yellowish gray in color and was traversed by distended blood vessels. On sectioning, the surface showed a uniform, fine lobulation of light yellowish-brown color. The remaining cut surface was pale, brownish-gray, with indistinct markings and circumscribed firmer, light pinkish gray nodes up to 9 Mm in diameter. In addition to these nodes, there were pinkish-brown, less sharply circumscribed areas up to 12 Mm in diameter. The gallbladder contained thin, light yellow bile and was practically normal. Pancreas weighed 105 Gm, was lobulated, moderately firm, pale yellow.

**Microscopic Examination**—(a) Tumor of the Left Lobe—Under low power the tumor resembles early periportal cirrhosis. The parenchyma is subdivided into various sized islands by branching septa of cellular connective tissue. The islands are com-



posed of well defined cords of liver cells without arrangement about the central vein. The liver cells are of uniform size. They have an ample, finely granular cytoplasm which contains a moderate amount of medium sized and large fat droplets. The nuclei are small and vesicular. The capillaries between the liver cell cords are lined by branched endothelium. Scattered between the liver cells are small groups of tubular gland like structures lined by cuboidal epithelium. These tubulae are most numerous in the periphery of the islands, where they border the connective tissue septa. These septa vary in thickness. They contain arteries and veins with very differentiated walls, but the lack of bile ducts is striking. There is a diffuse infiltration by small, round cells of lymphocytic type, which often form nodules.

(b) Tumor of the Right Lobe.—The acinar structure is very well defined and the

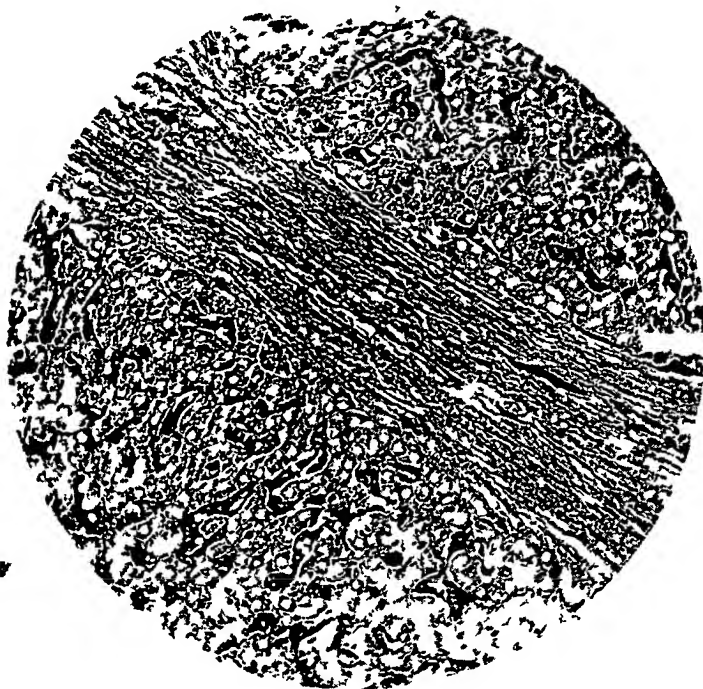


FIG 9.—Histologic aspect of tumor shown in figure 8

acini appear relatively large. The liver cells contain much less fat than in the tumor of the left lobe. Much fat, however, is present in the Kupffer cells. The periportal tissue is not more abundant than normal and is loosely infiltrated by leukocytes. There are areas which are composed of wide, blood filled spaces, separated by slender trabeculae of connective tissue. These blood spaces extend into the adjacent liver tissue. In some of these spaces the blood is coagulated.

The clinical case herein reported, supplemented by a second case which was discovered at postmortem, is presented with the purpose of familiarizing surgeons with both the clinical and anatomic manifestations of adenoma of the liver. While one must admit that there are no definite symptoms or laboratory methods by which adenoma of the liver can be diagnosed, a thorough knowledge of tumor masses in the right upper quadrant, coupled with a wide range of clinical possibilities occasioned by these tumors, may assist the surgeon in the differential diagnosis of upper abdominal masses in and about the liver region.



REFERENCES

- <sup>1</sup> Ascoli Policlínico, Rome (Surgical Section), 37, 309-360, July 15, 1930
- <sup>2</sup> Cammitti Arch f klin Chir, 69, 630, 1903
- <sup>3</sup> Cagnetto Arch per le Sc Med, 34, 495, Torino, 1910
- <sup>4</sup> Chahier and Martin Bull Soc Nat Chir, 55, 1385-1390-29, Paris
- <sup>5</sup> Chaillous Bull Soc Anat de Paris, 67, 572, 1898
- <sup>6</sup> Cullen, T S Arch Surg, 15, 718, Chicago, 1925
- <sup>7</sup> Fischer Deutsch Ztschr f Chir, 210-404, 1928
- <sup>8</sup> Finkelstein, B F Z Sovrem Chir, 5, 434-438, Russia, 1930
- <sup>9</sup> Greenfeld Arch f Heilk, 5, 1864
- <sup>10</sup> Gasparian Arch f klin Chir, 153, 458, 1928
- <sup>11</sup> Gutierrez, A, and Mouserat, J L Rev Chir Buenos Aires, 8, 1930
- <sup>12</sup> Hippel Virchows Arch, 201, 326
- <sup>13</sup> Heller Die Klinik der Bosartigen Geschwulste, von Zweifel and Payr, also, Kirschner and Norman Die Chirurgie, 59
- <sup>14</sup> Kretz Ergebnisse d Allg Pathol, 8th year, Pt II, 527
- <sup>15</sup> Lecene Rev de Gyn et de Chir Abd, 19, 555, Paris, 1912
- <sup>16</sup> Leppman Deutsch Ztschr f Chir, 54, 446, 1900
- <sup>17</sup> Major, Black and Donald Am Jour Med Sci, 156, 469, 1918
- <sup>18</sup> Milne Jour Pathol and Bact, 26, 475, Edinb, 1923
- <sup>19</sup> Perls Virchows Arch, 56
- <sup>20</sup> Pepere, A Arch per le Sc Med, 26, 117, 1902
- <sup>21</sup> Ramsey ANNALS OF SURGERY, 90, 41-46, 1929
- <sup>22</sup> Rolleston Diseases of Liver, Gall Bladder and Bile Ducts, 3d ed, p 479
- <sup>23</sup> Rosenstrich Virchows Arch, 261
- <sup>24</sup> Rubin Am Jour Obst, 77, 273, 1918
- <sup>25</sup> Shattuck, G B Boston Med and Surg Jour, 142, 427, 1900
- <sup>26</sup> Thole Neue Deutsche Chir, 7, 1913
- <sup>27</sup> Verebely Klin Wehnschr Year I, 704
- <sup>28</sup> Wagner Arch der Heilk, 1, 251, 1861
- <sup>29</sup> Wegelin Virchows Arch, 179, 96
- <sup>30</sup> Weller, C V Am Jour Med Sci, 150, 19, 696, 1925

# PERFORATED PEPTIC ULCER IN MECKEL'S DIVERTICULUM

REPORT OF A CASE OCCURRING INTRAMESENTERIC

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MECKEL<sup>22</sup> first described the diverticulum in 1812. During the past century frequent mention is found in the literature where this structure has been involved in various pathologic conditions.

No authentic report of a definite peptic ulcer formation within this organ was made until 1913 when Hubschmann<sup>13</sup> operated upon a four and one-half year old boy for an acute abdomen and found a perforated peptic ulcer in a Meckel's diverticulum. Examination of the specimen showed a typical perforated peptic ulcer with gastric mucosa lining nearly all of the diverticulum.

His findings were sufficiently important to direct surgical attention to the focus of a new disease, and since 1913 an increasing number of cases have been reported where the diverticulum has been similarly involved. The authors have been many, each one during the ensuing 20 years has helped in adding material to clarify the signs and symptoms and finally to succeed in having it recognized as a definite disease entity.

There are two main clinical manifestations resulting from this ulcer formation: the first is hemorrhage and the second perforation. Most of the available literature on this condition embraces the former, and for this reason I have chosen to analyze the perforative phase.

*Anatomy*—The diverticulum, in the vast majority of cases, is found within the terminal four feet of ileum, its size varies, but will average about one inch in length with a fairly broad base. Authentic reports state that it is found in 2 per cent of the bodies examined at autopsy. It is usually situated along the antimesenteric border of the ileum, but may be found at any point around its circumference. In rare instances it is completely hidden between the leaves of mesentery. The giant cystic diverticula occasionally encountered are usually of this variety, the cystic portion communicating with the bowel lumen by a long narrow neck.

For the sake of convenience the anatomic types most commonly seen can be grouped as follows:

(1) The typical diverticulum given off from the antimesenteric side of ileum, lying free in the peritoneal cavity, and presenting a closed distal extremity (82.5 per cent).

(2) Partial obliteration with a fibrous band running from the tip of the diverticulum to the umbilicus or to some adjacent structure (10 per cent).

(3) Umbilical fistula (6 per cent).

(4) The giant diverticulum of bizarre form or shape, sometimes coming

off from the mesenteric side of ileum and developing between the folds of the mesentery (0.5 per cent)

(5) The umbilical polyp, either attached to the remains of the omphalo-mesenteric duct inside the abdomen, or entirely cut off from internal connections (0.5 per cent)

(6) The simple intramesenteric variety (0.5 per cent)

The diverticulum may be lined with intestinal mucosa, duodenal mucosa, in part or entirely with gastric mucosa, with gastric mucosa and pancreatic tissue, or any combination of the intestinal, duodenal, gastric, or pancreatic elements. The type which concerns us here is the one which contains gastric mucosa, as it has been the universal experience that this is the variety in which a true peptic ulcer is likely to form.

*Etiology*—Table I reveals that in all but three instances gastric mucosa was found by the pathologist. The microscopic appearance of the ulcer, its tendency to be located within that portion lined by intestinal mucosa, but closely adjoining the gastric mucosa, links it definitely from an etiologic point of view with ulcers seen in the duodenum and about the stoma of a gastro-enterostomy. The evidence is so overwhelmingly in favor of the peptic genesis of these ulcers that one feels a sufficiently diligent search has not been made by the pathologist when gastric mucosa is reported absent.

*Incidence*—In this group of perforated ulcers 31 out of 36 occurred in males (86 per cent). The youngest was an infant 15 weeks old and the oldest was age 53. While 36 per cent occurred in children under the age of six, there was only one case occurring after the second decade (Table I).

*Past History*—Many cases give a history of previous, and often frequent, attacks of vague abdominal pain, which the mother had noticed since they were infants. In older children and adults the description is more helpful. In the case reported here the patient had frequent attacks of nausea and vomiting associated with abdominal pain years before blood was first noticed in the stool. Occasionally patients will notice a relationship between the onset of their pain and the ingestion of food, but this is a rare and undependable feature.

The most important symptom in these ulcers is a previous history of the passage of fresh blood by rectum; it is usually in the form of large dark clots freely mixed with feces and bright red blood. It should not be confused with the bloody mucus that accompanies an intussusception. They often describe an attack in which they first noticed lower abdominal discomfort rapidly progressing into "cramps" associated with nausea, then abruptly fainting. On regaining consciousness there is an urgent desire to "go to stool" with the subsequent copious passage of bright red blood. In cases of this sort they are gravely ill from the massive hemorrhage and take some time to recuperate.

The history of bleeding by rectum may have occurred years ago, or as recently as a few hours before the onset of perforative symptoms. On the other hand a perforation may occur without any previous history of bleeding.

TABLE I

Num- ber	Author	Year	Age Years	Sex	Gastric Mucosa Present	Perfo- ration Sealed Off	Result
1	Deetz	1907	9	M	Yes	No	Recovery
2	Hubschmann	1913	4½	M	Yes	No	Died
3	Gramen	1915	10	M	Yes	No	Recovery
4	Muller	1919	11	M	Yes	No	Recovery
5	Brasser	1924	15	M	Yes	No	Died
6	Guibal	1924	14	M	Yes	Yes	Recovery
7	Humbert	1924	11 mos	M	Yes	No	Died
8	Ulrich	1925	8 mos	M	Yes	No	Died
9	Etchegorry	1926	16	M	Yes	No	Recovery
10	Kleinschmidt (Case 1)	1927	15	M	Yes	No	Recovery
11	McCalla	1927	4	M	Yes	No	Died
12	Meiss	1928	2	M	Yes	No	Recovery
13	Hartglass	1928	4	F	Yes	No	Recovery
14	Peterman and Seeger	1928	6	M	Yes	Yes	Recovery
15	Schmidt	1930	18	M	Yes	No	Recovery
16	Fevre, Patel and Lepart (Cases 1 and 2)	1930	7	M	Duodenal mucosa	No	Recovery
17	Fevre, Patel and Lepart	1930	5 mos	M	Yes	No	Recovery
18	Green	1930	6½ mos	M	Yes	No	Died
19	Lindau and Wulff	1931	15	M	Yes	No	Died
20	Greenwald and Steiner (Cases 1 and 2)	1931	15 wks	M	Yes	No	Died
21	Greenwald and Steiner	1931	10	M	Yes	No	Recovery
22	Cobb	1931	18	M	Yes	No	Recovery
23	Debre, Bopp and Semelaigne	1931	17 mos	M	Yes	Yes	Died
24	de Vernejol	1932	5	M	Yes	No	Recovery
25	Vaughan and Singer	1932	7	M	Yes	No	Recovery
26	McKeen	1932	53	M	No	Yes	Recovery
27	Hudson and Koplik (Cases 13 and 25)	1932	6	M	Yes	No	Died
28	Hudson and Koplik	1932	5	F	Yes	No	Recovery
29 *	Schaff	1932	7	M	Yes	No	Recovery
30	Roudil and Marty	1932	7	F	Yes	No	Died
31	Mondor and Lamy (Prat's Case)	1933	4½	M	Yes	No	No mention
32	Johnston and Renner (Case 2)	1934	18 mos	M	Yes	No	Recovery
33	Weeder	1934	9 mos	F	Yes	Yes	Recovery
34	Treider	1934	6	M	No men- tion	No	Recovery
35	Chesterman (Case 2)	1935	11	F	Yes	Yes	Recovery
36	Thompson *	1936	14	M	Yes	No	Recovery

\* Intramenteric variety

per rectum One must not be confused by the story of "fever" that followed this "bloody diarrhea," as it is an almost constant feature, and is more marked in the younger subjects

There is a moderate rise in temperature following the shock of hemorrhage, but in these cases the process is augmented by some unexplained intestinal absorptive effect. The initial rise is abrupt to about  $101^{\circ}$  F per rectum, and varies for a few days before gradually returning to normal. In infants it may go as high as  $104^{\circ}$  F.

*Present Illness*—The perforation is usually preceded by nausea and vomiting. The pain, frequently cramp like, is at first located vaguely about the umbilicus, later shifting to a point just to the right of the midline in the lower abdomen. As the perforation becomes thoroughly established, the intensity increases and the localization is more definite, while, at a still later period, the pain will diffuse over the whole abdomen as the peritonitis becomes generalized.

This description only serves to emphasize how nearly identical the picture is to that found in the abdomen in acute appendicitis. The past history plays an important part in arriving at a correct preoperative diagnosis.

The temperature at first is only slightly elevated, around  $100^{\circ}$  F, the pulse accelerated accordingly, but they mount in proportion to the spread of the peritonitis. In contrast to any previous phase of the disease, there is no blood in the stool at this time, although it is conceivable that its last appearance may have immediately preceded the onset of perforative symptoms.

The abdominal signs are acute lower abdominal tenderness, steadily increasing and localizing just to the right of midline in the hypogastrium, with attending muscle spasm which progresses to a generalized abdominal rigidity.

The onset is not as dramatic or as "lightning like" as one sees in a perforated duodenal ulcer. This may be explained in two ways. Primarily, in a duodenal ulcer the stomach contents, under pressure, are expelled through the perforation in an almost continuous stream, while in the terminal ileum the pressure is negligible and the contents are passing along in small quantities by peristaltic motion. This latter feature accounts for the "cramp like" or intermittent nature of the pain, as the intestinal contents are first extruded with each rhythmic wave of peristalsis. Secondly, the duodenum is fixed and cannot help in sealing off its ulcerated opening against an adjacent organ or viscus, while the mobile terminal ileum, with its free appendage, can attempt to evade disaster by trying to seal its opening against bladder, omentum or neighboring intestine. This latter feature is described in greater detail under pathology.

The laboratory findings are no different from those found in acute appendicitis. There is an early elevated leukocyte count with a polynucleosis, which rises rapidly with progressive peritoneal involvement. The urine is usually negative, but may show a few pus cells or an occasional red blood cell, particularly if the diverticulum has become adherent to the bladder serosa.

*Diagnosis*—The main basis upon which a diagnosis must be made is the comparatively sudden onset of an acute abdomen resembling that seen in

appendicitis, where there is a past history of the passage of a quantity of bright red blood by rectum

If the patient is an infant, especially if a male, and the roentgenogram of the abdomen shows a gas bubble beneath the right or left leaf of the diaphragm, the diagnosis is certain. Otherwise it is a difficult diagnosis to make pre-operatively, but when operating, should always be kept in mind, particularly when a diffuse peritonitis of obscure nature is encountered.

*Treatment*—As soon as a diagnosis is made, an immediate operation is indicated. The best exposure is obtained through a lower right rectus incision. The diverticulum when found should be amputated at its base, and closure of the small intestine performed by any manner which has met with the greatest success by the operator when doing previous small intestine surgery.

If the perforation occurs in the intramesenteric variety of diverticulum, a resection of intestine, including the wedge of mesentery that contains the diverticulum, will be necessary. End to end or side to side anastomosis should then be performed, the latter is the safer.

Closure in the early cases should be done without drainage. In the late instances, it is a matter of individual preference and judgment as to the exact placing of the drains.

*Gross Pathology*—In early cases the peritoneal cavity will be found filled with a slightly turbid, thin, and often blood tinged fluid, later this will become frankly purulent. The perforation is perhaps most often seen in the angle where the diverticulum joins the ileum, but may be encountered at any point along its surface to its very tip.

There is frequently an inflammatory reaction in the diverticulum secondary to the ulceration, giving it somewhat the appearance of an acute appendix. Undoubtedly this resemblance has accounted for the failure in the past to place them in a separate group as being primarily due to ulceration and not to inflammation. When the ulceration occurs at or near the tip, it may attempt to seal itself off against an adjacent organ such as the urinary bladder, small or large intestine. Sometimes this performance is effected, and either results in a complete resolution of the process, the production of a localized abscess, or the formation of a fistula between the ileum and the organ thus attached.

In the average case the perforation is gradually established with the expulsion first of gastric juice and mucus, then an increasing amount of small intestinal contents. The nearer to the base of the diverticulum it occurs, the greater will be the soiling and proportionately more rapid and severe the peritonitis.

*Microscopic Pathology*—In order to properly interpret the microscopic pathology that can be found in these cases it might be wise at this point to mention what one should expect to see in a normal Meckel's diverticulum.

It has been said that in about 84 per cent of the cases one will find the diverticulum completely lined with intestinal mucosa, and that in the re-

mailed (16 per cent) one finds dystopic mucosa containing acid cells histologically analogous to the fundic mucosa of the stomach. This incidence is more than likely underestimated, as the gastric mucosa when present is often scattered in small islets along the diverticular wall. Unless a conscientious and diligent search is made, it is quite conceivable that it might be overlooked. Longitudinal sections from base to tip of the diverticulum, rather than the usually circular section, are for this reason recommended as much more likely to include the gastric mucosa in elusive cases. In some instances a considerable portion of the lining is gastric in type and may even present a thickened glandular appearance to the naked eye. Here one encounters no difficulty. Occasionally islets of pancreatic tissue, or mucosa of the duodenal variety, are seen, but their presence bears no direct significance to ulcer formation at this site.

On examining the specimen which presents the perforated ulcer, it is wise to make a section passing through the ulcer and extending from base to tip of the diverticulum. Upon examining this type of section one sees the typical ulcer base lying within that zone lined by intestinal mucosa but directly adjoining the gastric area.

The ulcer is usually round, with sharp, well defined margins, showing a disrupted muscularis mucosa and a callous base. The surrounding mucous membrane may show various degrees of chronic inflammation with hyperemia and cellular infiltration. In addition there may be a superimposed acute inflammatory reaction with sufficient hyperemia and infiltration with polymorphonuclear leukocytes to greatly mask the underlying chronic pathology.

*Mortality*—The mortality in the presented group of cases (which represents all that have been reported up to 1936) is 31 per cent. In the study of each individual case it is evident that the mortality increases with the length of time which elapses between perforation and operative intervention, and was lower in those cases where the perforation was "sealed off." The analysis of the different age groups bears out the findings in all surgery that the mortality increases as one gets into the lower brackets (Table II).

TABLE II  
MORTALITY IN RELATION TO AGE GROUPS

Age	Mortality
Under 1 year (inclusive)	66 Per Cent
1 to 5 years (inclusive)	28
6 to 10 " "	22
11 to 18 " "	20

### CASE REPORTS

**B 29100**—Male, age 12, student

*Present Illness*—This boy was admitted to Roosevelt Hospital September 20, 1930. He gave a history of suffering from severe abdominal cramps 12 days prior to admission. They were first localized vaguely about the umbilicus, but gradually extended over the lower abdomen. These cramps lasted approximately six days and were terminated by the sudden appearance of bloody stools. The cramps as described were of a gripping

nature and recurred about every 25 minutes, lasting usually ten to 15 minutes. The stools were soft and filled with dark clots, but also contained considerable fresh blood. On the morning of admission, while at school, he felt suddenly dizzy and abruptly fainted.

*Past History*—He had been subject to attacks of nausea and vomiting most of his life. Three years ago he had a similar attack of cramps, but noticed no passage of blood. Family history negative.

*Physical Examination*—General appearance somewhat anemic. Abdomen soft, no palpable masses. Liver, spleen and kidneys not palpable. No pain or tenderness on superficial or deep palpation. No visible peristalsis. Extremities reflexes normal. Otherwise essentially negative.

*Laboratory Data*—Urine. In several specimens a few red blood cells were detected. In each specimen occasional leukocytes were seen, otherwise they were negative.

Blood. September 20, Hb 50 per cent (Talquist). RBC 2,050,000. WBC 6,000. Polys 66 per cent. Lymph 30 per cent. Platelets 110,000. Bleeding time two minutes. Coagulating time three minutes. Blood chemistry normal. Blood culture sterile. Blood Wassermann negative. Widal negative.

Feces. Benzidine test positive for blood.

*Roentgenologic Examinations*—Abdomen and pelvis negative for any evidence of stone along the course of the ureter, or in the pelvis. Negative for any definite intra-abdominal pathology.

*Course*. The patient during his first two days had a quantity of bright red blood in his stools and ran a temperature which varied from 100° to 101°F. It was decided that he did not present a condition requiring surgical attention, a medical consultation was requested, and the consultant favored the diagnosis of Henoch's purpura and requested that he be transferred to the Medical Ward, where he remained until his discharge October 19.

During his stay on the Medical Ward his temperature gradually receded and on October 7 had returned to normal. His blood count gradually increased and at the time of discharge was 4,060,000. He was discharged cured with the diagnosis of Henoch's purpura October 19, 1930.

#### SECOND ADMISSION SURGICAL WARD, ROOSEVELT HOSPITAL

B 31258—May 25, 1932. Patient now age 14.

*Interval History*—The patient has felt very well since his discharge. He has attended the O P D from time to time for check-up examinations, and was symptom free up until two weeks ago when he began to have cramp like abdominal pains, which were severe enough to prevent him from attending school. Three days ago the cramps became so acute that he was compelled to remain at home. On day of admission his pain was so intense that the clinic doctor was requested to visit the patient at his home, and upon examination, felt that he had an acute appendicitis and suggested his immediate removal to the hospital.

*Present Illness*—The patient says that the present attack of pain is much more severe than on his previous admission, and that it tends to localize definitely in the R L Q. Following his arrival he vomited. There have been no bloody stools or purpuric spots on this occasion.

Roentgenologic examination taken in O P D a few days prior to admission reports 'G I Series, fluoroscopic examination and films of the stomach following a barium meal demonstrate no organic change of the stomach or duodenum. There is normal motility of the meal seen on the six hour plate.'

*Physical Examination*—General appearance a well developed and well nourished young boy, lying quietly in bed. Abdomen the palpation reveals a slight amount of rigidity of the lower right rectus muscle. There is marked tenderness over McBurney's point as well as rebound tenderness all over the abdomen. Rectal examination shows a slight amount of tenderness high on the right. Otherwise essentially negative.



*Laboratory Data*—Urine negative WBC 12,200 Polys 74 per cent Temperature 100°F

In spite of his previous history and diagnosis of Henoch's purpura, a diagnosis of acute appendicitis was made and immediate exploration advised

*Operation*—Under gas-oxygen-ether anesthesia the abdomen was opened through a lower right rectus incision, extending from the umbilicus to the symphysis pubis The peritoneal cavity was filled with about a pint of serosanguineous fluid The appendix and entire ileum showed a mild degree of injection, but the appendix did not show sufficient pathology to account either for his symptoms or the peritoneal exudate Exploration of the small bowel was commenced at about the jeuno-ileal juncture

As the examination progressed distally a few flecks of clotted blood were found adherent to the mesentery In wiping these off, a small nodular swelling adjoining the mesenteric border of the gut, measuring about  $3\frac{1}{2}$  cm in diameter, involving the entire thickness of mesentery was found It was situated at a point 21 inches from the ileocecal

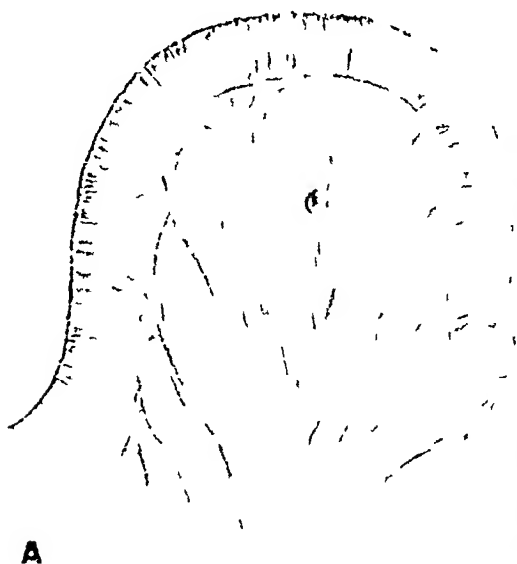


FIG 1(A)—A diagrammatic representation of the intramesenteric diverticulum as found at operation (actually the perforation was nearer the base of the diverticulum, as can be seen in Fig 1(B))

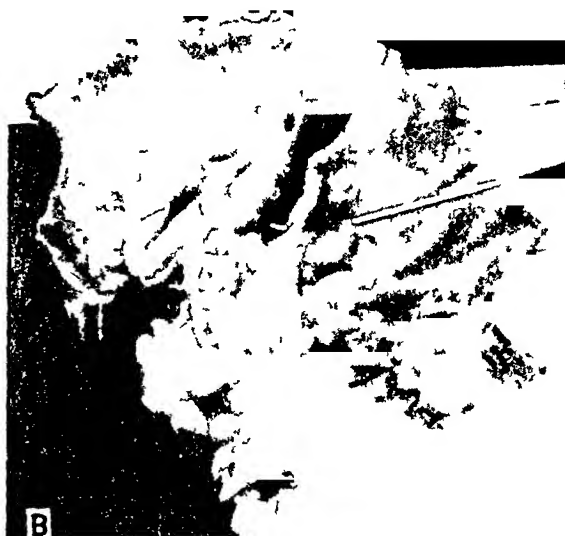


FIG 1(B)—Showing the specimen removed at operation The diverticulum has been opened from its tip to its base the incision being carried through the entire circumference of the already opened ileum The probe is seen passed through the perforation from the serosal to the mucosal side The thick adenomatous appearance of the walls of the diverticulum in its distal half is actually thick gastric mucosa

valve The tumor was hard in consistency, and on the side facing the pelvis presented a small perforation into which the tip of a curved clamp could be passed, and from which were expressed several drops of mucopurulent material A probe was then passed into the opening, but at that time it was felt that it did not pass into the lumen of the gut (Fig 1A)

Feeling that we were dealing with a small bowel malignancy, probably sarcomatous, which had perforated, it was decided to resect This was accomplished, removing about five inches of intestine, two inches to either side of the growth, including a wedge shaped portion of mesentery that contained a few enlarged mesenteric lymph nodes After inversion of the ends of proximal and distal loops of the bowel, a lateral entero-anastomosis was performed, using two layers of continuous tanned catgut, reenforced with several interrupted sutures at either end of the anastomosis The leaves of mesentery were sutured to one another by means of several interrupted catgut sutures The abdomen was closed without drainage

*Pathologic Report*—By Dr Lawrence Sophian Macroscopic Examination—There is a piece of ileum 12 cm long and  $5\frac{1}{2}$  cm in circumference. In its central portion a projection into the mesenteric attachment is noted. This consists of a tubular prolongation of the intestinal wall covered with hemorrhagic, slightly roughened serosa, and measuring 27 cm in length and 1.9 cm in diameter. It has a rounded end which is covered with about 1 cm of fat containing pale nodules which seem to be lymph nodes. The mucosal aspect of the ileum shows opposite this protrusion an opening 4 mm wide with somewhat elevated, smooth borders. On section through this opening there is found an expansion 1 cm wide lined with smooth mucous membrane, and beyond this a firm mucoid wall 1 cm thick with numerous pockets filled with mucus and many reduplicated folds of mucous membrane. There is a perforation of minute size extending through the wall at the base of the expansion and emerging under a small fold of fat on the mesenteric border (Fig 1B). The serosal surface along this zone is covered with a deposit of fibrin. There is no gross pus.

Microscopic Examination—Sections taken through the fundus of the diverticulum



FIG 2—The mucosal aspect of the opened diverticulum probe passed through the perforation. The dark spot just above the tip of the probe was a hemorrhagic spot, a probable source of fresh bleeding, accounting for the blood tinged appearance of the peritoneal fluid.

show large areas of epithelial cells which appear to resemble gastric mucosa. Both mucous producing cells and the gastric cells which produce pepsin and acid are present. The acid producing cells lie as red acid staining cells on the periphery of acini of basic staining pepsin producing cells. These gastric cells occur in large sheets and account for the bulk of the tumor mass in the diverticulum.

A section taken through the ulcerated area at the junction of the diverticulum and the gut wall shows a fibrin covered base of an ulcer underlined with an infiltration of inflammatory cells and some evidence of hemorrhage. Still deeper in this section can be seen the normal epithelium of the ileum linking the gut wall. Another section taken through one of the lymph nodes at the base of the fundus shows merely some hyperplasia of the adenoid tissue.

*Diagnosis*—Congenital intramesenteric diverticulum of ileum (Meckel's) with peptic ulcer formation and perforation.

*Postoperative Course*—His convalescence was uneventful until June 14, when he suddenly became nauseated and commenced vomiting. This continued through June 15 and was associated with a gradually developing distension. On June 16, after 36 hours

of vomiting and with every evidence of an acute ileus, an exploratory celiotomy was performed through the old incision. Numerous adhesions and several large bands were located and found to be causing definite mechanical obstruction. These were severed and the gut found to be viable. The anastomosis was located and gas was seen to pass through it readily. The abdomen was closed without drainage.

His convalescence from this second operation was rather stormy and on June 26 he developed a second, but less severe, intestinal obstruction which was eventually relieved by conservative means. He was finally discharged July 12, 1932, greatly improved. When last seen in September, 1935, had had no further abdominal symptoms and is now a full grown, healthy looking young man.

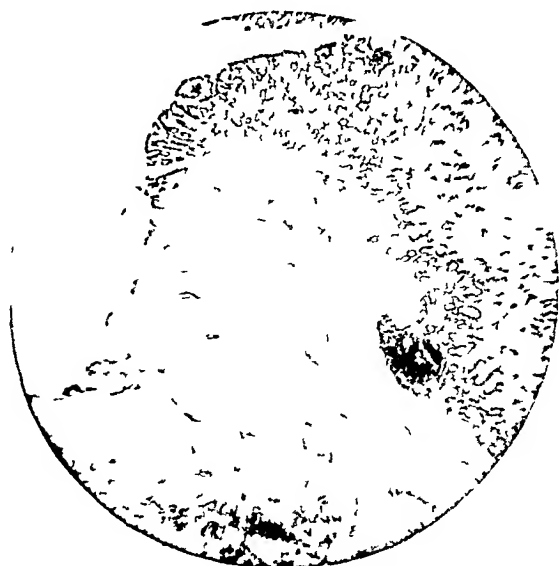


FIG 3—Photomicrograph of the callous ulcer base (X 30). At the top of the section passing to the right of the scarred ulcer one sees first intestinal mucosa and then a sharp transition to the gastric type with innumerable deep seated glands.

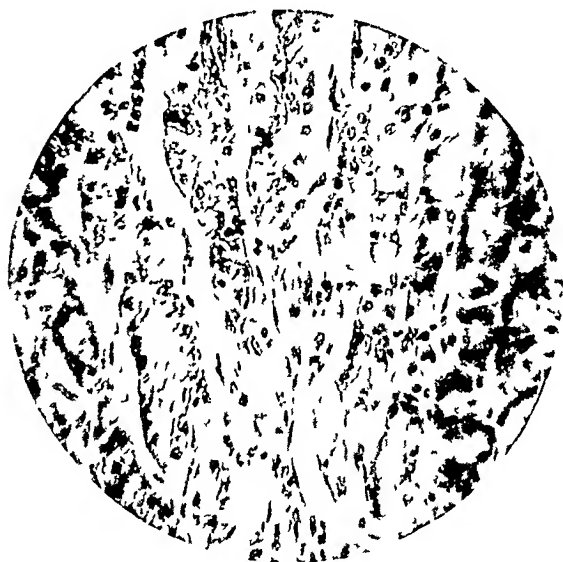


FIG 4—Photomicrograph of a section taken through the gastric mucosal area of the diverticulum. The long glands with the chief and parietal type of cells are clearly demonstrated.

### SUMMARY

The perforative phase of peptic ulcer formation in Meckel's diverticulum is described.

All the previously reported cases in the literature are collected and analyzed.

Great stress is laid upon the following features:

- (1) The passage of a quantity of fresh blood by rectum is the most important diagnostic finding, as elicited from the past history.
- (2) The tendency for the disease to manifest itself in infancy.
- (3) The predilection for the male.
- (4) The difficulty in making a correct preoperative diagnosis.
- (5) The similarity of the abdomen to that seen in acute perforative appendicitis.

The similarity between these ulcers and those seen in the duodenum and about a gastro-enterostomy, particularly in regard to etiology, histology and pathologic physiology.

A very unusual variety is reported that has not been exactly duplicated in the past literature on the subject.

## CONCLUSIONS

(1) That wider attention should be directed to a clinical entity whose probable prevalence is undetermined as yet, due to improper interpretation of rectal bleeding

(2) That hemorrhage and perforation are the two main symptoms of the disease, and that a high mortality rate (31 per cent) attends the latter phase

(3) That operation is indicated after the hemorrhagic phase, to obviate a future potential perforation

(4) That immediate operation is indicated after perforation occurs

(5) That an erect plate of the abdomen aids in making the final diagnosis

(6) That the presence of gastric mucosa somewhere within the diverticulum is an almost constant finding

(7) That in failing to find a typical diverticulum at operation, one should carefully search, by palpation and direct vision, the mesentery of ileum, to rule out the possibility of an existing intramesenteric variety

## BIBLIOGRAPHY

- <sup>1</sup> Abt, I A, and Strauss, A A JAMA, 87, 991, September 25, 1926
- <sup>2</sup> Borrmann, R Deutsche med Wchnschr, 58, 43-45, January 8, 1932
- <sup>3</sup> Cahill, J A Virginia M Monthly, 56, 474-477, October, 1929
- <sup>4</sup> Chesterman, J T Brit J Surg, 23, 267-273, October, 1935
- <sup>5</sup> Cobb, D B ANNALS OF SURGERY, 94, 256-262, August, 1931
- <sup>6</sup> Debre, R, Boppe, H, and Semelaigne, G Bull Soc de pediat de Paris, 29, 402, 1931
- <sup>7</sup> De Vernejol, R Provence medicale, abstr Arch de med d enf, 35, 293, 1932
- <sup>8</sup> Etchegorry, J Ann Fac de med, Montevideo, 11, 621, 1926
- <sup>9</sup> Farr, C E, and Penke, M ANNALS OF SURGERY, 101, 1026-1041, April, 1935
- <sup>10</sup> Fevre, M, Patel, and Lepart Bull et mem de la soc Nat de Chir, 56, 756-767, 1930
- <sup>11</sup> Green, D A Internat S Digest, 10, 259, November, 1930
- <sup>12</sup> Greenwald, H M, and Steiner, M Am J Dis Child, 42, 1176, November, 1931
- <sup>13</sup> Hubschmann Munchen med Wchnschr, 60, 2051, 1913
- <sup>14</sup> Hudson, H W, Jr, and Koplik, L H New Eng J Med, 206, 827, April, 1932
- <sup>15</sup> Humbert, Jean Paris Theses, No 395, 1924
- <sup>16</sup> Jackson, A S ANNALS OF SURGERY, 85, 252, 1927
- <sup>17</sup> Johnston, L B, and Renner, G, Jr Surg, Gynec and Obst, 59, 198-209, 1934
- <sup>18</sup> Lendormy, G L Paris Theses, No 7, 1922
- <sup>19</sup> Lindau, A, and Wulff, H Surg, Gynec and Obst, 53, 621-634, November, 1931
- <sup>20</sup> McKeen, H R Col Med, 29, 258, June, 1932
- <sup>21</sup> Mason, J M, and Graham, G S ANNALS OF SURGERY, 96, 893-910, November, 1932
- <sup>22</sup> Meckel, J F Hand der Path Anat, 1, s 553, 1812
- <sup>23</sup> Moll, H H Brit J Surg, 14, 176, 1926
- <sup>24</sup> Mondor, H, and Lamy, M Jour de Chir, 41, 553-584, 1933
- <sup>25</sup> Montgomery, A H Internat Clin, 1, 216-225, March, 1935
- <sup>26</sup> Muller, P F Beitr z klin Chir, 115, 560, 1919
- <sup>27</sup> Reed, J C J Coll Surg Australasia, 36, 861-867, 1930
- <sup>28</sup> Renner, G, Jr Ohio State Med J, 30, 371-373, June, 1934
- <sup>29</sup> Roudil, G, and Marty Bordeaux Chir, 3, 179-181, 1932
- <sup>30</sup> Ruge, E Med Welt, 8, 645, May 12, 1934, 8, 689, May 19, 1934
- <sup>31</sup> Schaetz, G Beitr z path anat u z allg Path, 74, 115-293, 1925
- <sup>32</sup> Schaff G Deutsche Ztschr f Chir, 238, 78, November, 1932
- <sup>33</sup> Schullinger, R N, and Stout, A P Arch Surg, 28, No 3, 440-466, 1934.

- <sup>34</sup> Struthers, J W Edin M J , 1911
- <sup>35</sup> Struthers, J W Edin M J , 37, 403-408, 1930
- <sup>36</sup> Stulz, E, and Woringe, P ANNALS OF SURGERY, 83, 470, 1926
- <sup>37</sup> Travaglini, V Ann ital di chir , 12, 1085-1118, September 30, 1933
- <sup>38</sup> Treider, P Norsk mag f laegevidensk , 95, 393-398, April, 1934
- <sup>39</sup> Vaughan, T , and Singer, H A ANNALS OF SURGERY, 96, 230-239, August, 1932
- <sup>40</sup> Von Haberer, H Deutsche Ztschr f Chir , 225, 131, 1930
- <sup>41</sup> Weeder, S D ANNALS OF SURGERY, 100, 550-553, September, 1934
- <sup>42</sup> Yates, H B Brit J Surg , 17, 456-462, January, 1930

## MORTALITY IN ACUTE APPENDICITIS\*

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THERE is no doubt that there is a rising mortality in acute appendicitis. Doctor Kiech has brought this out very strikingly in his report. Although I will emphasize the delayed operation in acute appendicitis, I should like to present some figures which I believe explain, somewhat, this increasing mortality. Dr. Murat Willis compiled the statistics shown in Charts 1, 2 and 3, which are based on a United States Government report of mortality per each 10,000 deaths. This has not been continued since 1925, but the rise shown, according to all reports, is still continuing in acute appendicitis.

In a study of Chart 1, it is interesting to note that the mortality dropped during the war. This may be due to the fact that many young men in the appendicitis age were overseas, or to other factors which may have entered at this particular time. During the period of preparation for the war, a great many men who had not done surgery were trained in Government hospitals for war surgery. After the completion of the war many of these men continued to do surgery. Unquestionably many of them have done excellent surgery and others have not done so well.

One can see, by a study of Chart 2, that the mortality of appendicitis in 1925 had risen above that of the puerperal state. During this same period of time there were three main advances in surgery, *viz.* surgery of goiter, cholelithiasis and of gastric and duodenal ulcer. Chart 3 shows that there has been a proportionate rise in the mortality of these diseases. A study of the statistics of the surgical clinics of the country does not show this increased mortality. The mortality in ulcer, goiter and gallstones has decreased in the statistics presented by many surgical clinics. In appendicitis, surgical clinics present statistics that are approximately the same during the past 20 years. Finally, if we compare the United States Government mortality statistics with those occurring in surgical clinics, we must assume that the increased mortality observed in the Government reports is due to the surgery that is being performed in private sanitariums and smaller hospitals in the large cities and to the increased surgery that is being performed throughout the country in the smaller cities and outlying districts.

Table I shows published statistics during this period of time from several clinics in America. I have recently had Doctor Skoluda analyze a series of 350 consecutive cases of acute appendicitis, occurring on my own service at the Fifth Avenue Hospital, and compared it with a series which I had analyzed on Doctor Pool's service at the New York Hospital in 1920. It will

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\* Read before the New York Surgical Society, November 27, 1935. Submitted for publication April 18, 1936.

# ACUTE APPENDICITIS

CHART 1  
DEATH RATE IN USA FROM APPENDICITIS  
NOTE DECLINE IN RATE DURING WORLD WAR  
DEATH RATE SHOWN IN FIGURES ON GRAPH

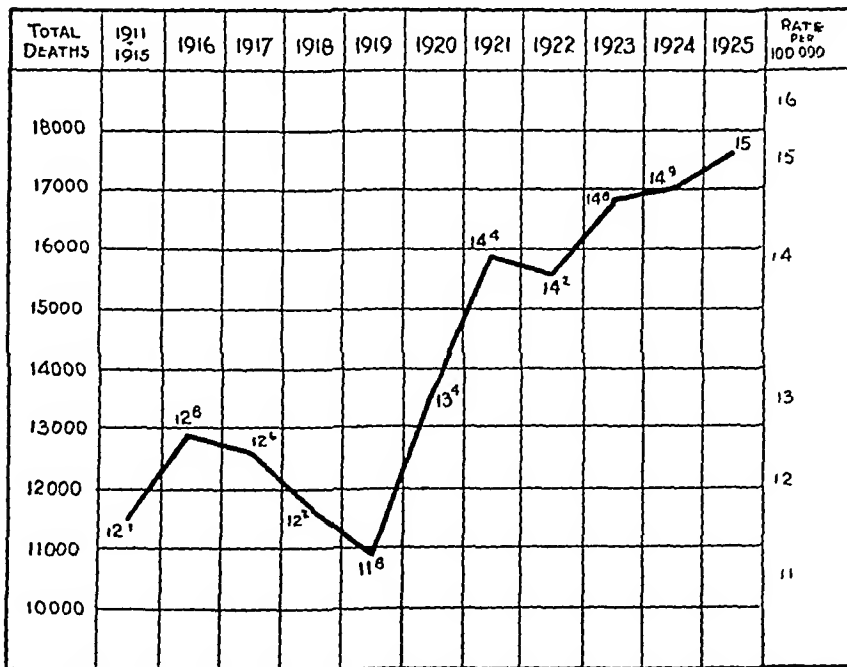
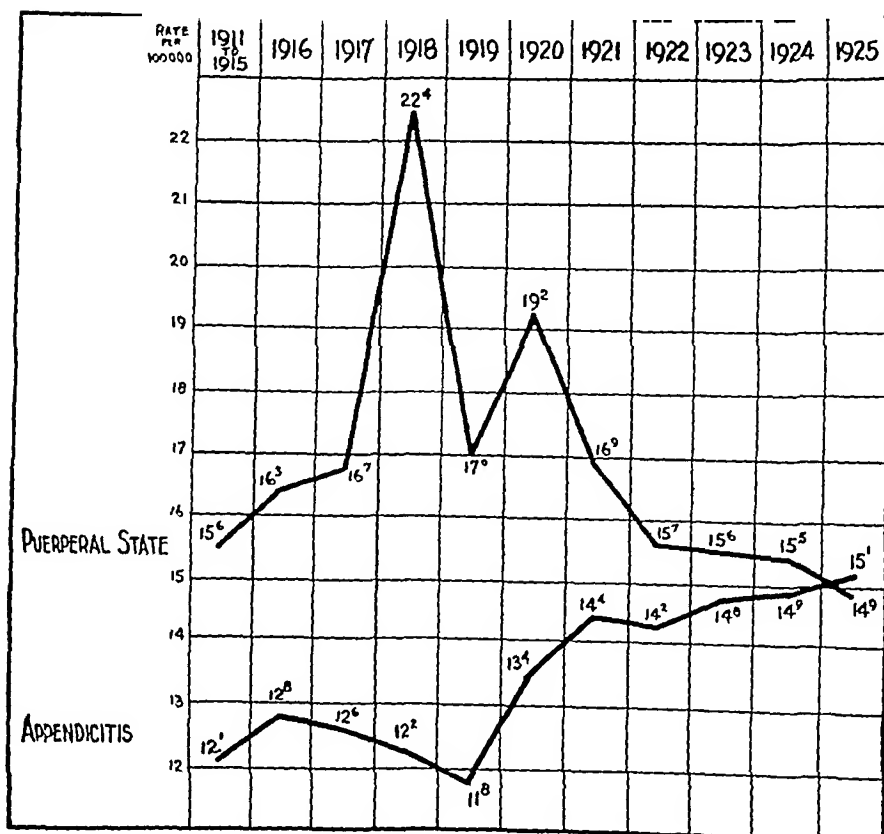
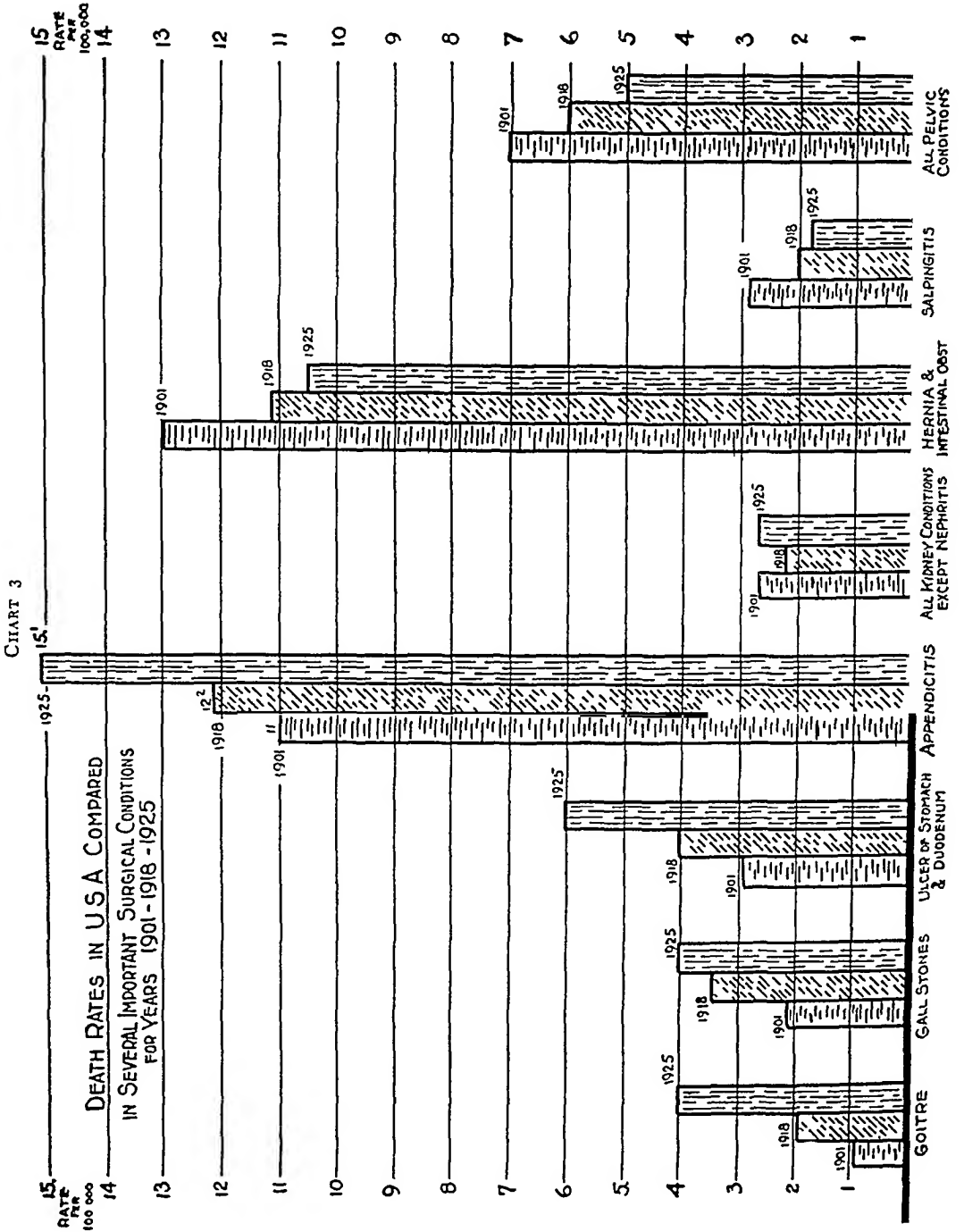


CHART 2  
PUERPERAL STATE VS APPENDICITIS  
FIGURES SHOW DEATH RATE PER 100,000 POPULATION IN USA







# ACUTE APPENDICITIS

be noted that the mortality rate in these two services is approximately the same, and this corresponds almost identically with the series published by Garlock, Christopher and Jennings, Finney, and McClure, in various parts of the county. It is also interesting to note that in my previous series and the present one, as is shown on Table II, the mortality is higher in the first decade of life, then decreases until the fourth decade and rises with each decade thereafter.

TABLE I  
MORTALITY RATE IN VARIOUS HOSPITALS

Author	Hospital	Cases	Deaths	Per Cent
Bancroft and Skoluda	Fifth Avenue Hospital	350	15	4.3
Garlock	New York Hospital	304	17	5.5
Christopher and Jennings	Evanston, Ill	1,138	47	4.13
Finney	Union Memorial	1,804	91	5.0
Bancroft	New York Hospital	584	25	4.2
McClure	Ford Hospital	940	29	3.0

TABLE II  
MORTALITY BY DECADES

Age	New York Hospital			Fifth Avenue Hospital		
	No of Cases	Deaths	Mortality Per Cent	No of Cases	Deaths	Mortality Per Cent
0-10	65	7	10.9	78	4	5.1
11-20	201	5	2.4	117	2	1.7
21-30	182	2	1.1	80	2	2.5
31-40	83	7	8.5	38	0	0
41-50	43	1	2.3	16	2	12.5
51-60	6	2	33.3	14	2	14.3
61-70	4	1	25.0	6	2	33.3
71-80				1	1	100.0

A study of the mortality of the early cases where the disease is confined to the appendix or its immediate vicinity, as is shown in Table III under those cases classified Without Adjacent Peritoneal Reaction and with Free Fluid, shows a very negligible mortality. This means that if a case is referred to a surgeon in the first 24 hours the mortality is practically nil. On the other hand, if the case is delayed until abscess or diffuse peritonitis occurs, then the mortality increases to a surprising degree. In our own series of diffuse peritonitis cases at the Fifth Avenue Hospital it will be noted (Table III), that we have had eight such cases with eight deaths. I do not believe this is an accurate account of the number of spreading or diffuse peritonitis cases that were seen on our service. It is almost impossible, through a small McBurney incision, to be able to determine the general pathology. Also various men account for pathology in various ways. What one man would call Free Fluid another one might call Peritonitis.

TABLE III

## MORTALITY ACCORDING TO PERITONEAL REACTION

	Fifth Avenue Hospital			Bancroft			Garlock		
	No of Cases	Deaths	Per Cent	No of Cases	Deaths	Per Cent	No of Cases	Deaths	Per Cent
Without adjacent peritoneal reac	129	0	0	246	2	0 8	245	2	0 7
With free fluid	148	5	3 3	127	5	3 9			
Acute diffuse peritonitis	8	8	100	73	13	17 8	23	10	43
With abscess	46	2	4 3	133	5	4 3	36	5	13

An analysis of Table IV reveals that the complications, with the exception of hematomata, are strikingly decreased in the undrained as compared with the drained cases. If we assume in general that the undrained cases are the early ones, this decrease in morbidity is also an important factor in advocating early operation in acute appendicitis.

TABLE IV

## COMPLICATIONS IN DRAINED AND UNDRAINED CASES

	Drained		Undrained	
	No	Per Cent	No	Per Cent
Infected wounds	12	10 5	3	2 6
Hematomata	2	1 6	9	7 8
Secondary abdominal abscess	5	4 6	1	0 8
Intestinal obstruction	1	0 8	1	0 8
Paralytic ileus	2	1 6	0	0
Fecal fistula	3	2 6	0	0

As an effort to combat the high mortality in diffuse peritonitis and appendiceal abscess the problem of delayed operation in acute appendicitis has come largely to the fore in the last few years.

At a meeting of the Medical and Postgraduate Medical Association of Great Britain, presided over by Lord Moynihan, a very heated, and at times vitriolic debate, took place. At this particular meeting a motion was made that every case of acute appendicitis should be operated upon immediately after admission to the hospital, no matter how long after the onset of the disease it might be, and, to show the evenness of opinion on this subject, the final vote was in favor of the motion by 54 to 49.

The Ochsner method of treating peritonitis, which in England is called the Ochsner-Sherren method, has, within the last five years, gained many supporters, and the statistics given by these men are well worth considering. Love, who is its chief proponent in England, has stated that the mortality from delayed operation, after employing this form of treatment, reduces the mortality from some place between 15 and 65 per cent to an approximate 6 per cent. He states that 65 per cent of those recovering convalesced without an immediate operation, and they were sent for, to return for an appendectomy, one to three months after leaving the hospital. Twenty-five per

cent formed a localized abscess which was drained after the abscess was well localized, and 10 per cent required an emergency operation during the course of the disease. Geary reports a mortality in the delayed operation in cases of appendicitis with peritonitis of 2 per cent. Collier and Potter, in analyzing appendicitis of the three- and five-day variety, reported 85 cases with eight deaths, a mortality of 9.3 per cent. The average length of time before the patient entered the hospital after the onset of the disease was 3.1 days. Of the 77 cases who survived, they report that 29, or 37.6 per cent, recovered without any further immediate operative procedure. Forty-eight cases, or 62.4 per cent, developed an abscess which required drainage. Staunton reports 113 cases with peritonitis. Of these 31 had an immediate operation performed, with 13 deaths, or a mortality of 42 per cent. Eighty-two had delayed treatment, with seven deaths, or a mortality of 8.5 per cent. Staunton emphasizes the fact that the more severe cases were given the delayed treatment, while the operative cases were those which they thought had the better prognosis.

It would seem that the Ochsner treatment, which was originally described in 1892, with certain modifications that have been acquired through the progress of medicine during the intervening years, should receive more attention than it does at present. It is my impression that this method is being used to a much larger degree in other parts of the country than it is in New York City. Indeed, it takes more courage not to operate than it does to operate.

In reviewing the various accounts of the Ochsner treatment it would seem possibly wise to review its salient factors. Love states that it demands four f's: fluids, fomentations to the abdomen, four hour chart (which means careful observation) and Fowler's position.

Alton Ochsner recommends (1) the administration of fluids to combat dehydration, (2) absolute rest of the gastro-intestinal tract, (3) the application of heat to the abdomen, and (4) the Fowler position.

(1) Fluids are administered as a rule intravenously. Staunton recommends the continuous intravenous administration of saline and glucose, about 5,000 cc. in 24 hours. Ochsner recommends intravenous medication up to 3,000 cc. and prefers Ringer's solution or some modification of it, in order that calcium and sodium may be administered also.

(2) The intestinal tract is placed at rest by the administration of morphine sufficient to reduce the respiration to 12 or 16 per minute. Morphine is given, according to Ochsner, because it increases the tone of the bowel and prevents its excessive dilatation, with its concomitant intramural strangulation. While morphine is being administered Collier advises gum chewing, in order to prevent parotitis, and Ochsner suggests that oxygen be given to those cases deeply narcotized. Vomiting is prevented by the use of the duodenal tube inserted through the nares and if possible inserted deep enough so that it enters the duodenum and thus may remove the pancreatic

and upper duodenal secretions. No fluid is given by mouth and no attempt is made to move the bowels by either oral or anal administration.

(3) Many men advise the application of hot compresses, turpentine stupes or mustard pastes, but Ochsner recommends the use of a hot air tent, as he suggests it has been demonstrated by Mueller that by producing vasodilatation of the somatic area a vasoconstriction of the splanchnic vessels results.

(4) The Fowler position is recommended because it allows the gravitation of the infected exudate into the pelvis and decreases the percentage of subphrenic abscesses. In many cases the abscess may become localized in the pelvis and can be drained through the culdesac or the rectum.

My own experience in this type of case has been limited to three cases, largely because, until recently, I have been somewhat of a coward in adopting this procedure. I am convinced that the treatment must be carried out in its full detail to be successful. In the cases in which I have employed it I have been surprised to see how little distention there has been and how a seriously ill patient may recover.

On the other hand, I have operated upon two or three cases of pelvic peritonitis following appendicitis where the operative procedure apparently made the patient much worse and a fatality resulted within 36 to 48 hours postoperative.

#### CONCLUSIONS

It would seem to me that if we are to improve the rising mortality figures in appendicitis we must do so

By public education, stressing strongly that cathartics should not be given in cases of abdominal pain, and that a doctor must be consulted immediately.

We must still stress, to the general medical profession, the importance of referring cases of appendicitis to the hospital early in the disease.

We must, if possible, so improve the standards of surgical practice that surgery should be undertaken by the best educated group.

We must, ourselves, improve our methods of treatment, in order to reduce the high mortality in those instances occurring of abscess and general peritonitis.

**DISCUSSION**—DR ALLEN O WHIPPLE (New York) presented Tables I and II for the purpose of emphasizing the advantages of making a regular study of the appendicitis incidence and mortality in a hospital, so as to keep it before the staff regularly and periodically, and expressed his appreciation to Dr Rudolph N Schullinger<sup>1</sup> of the Surgical Staff of Presbyterian Hospital for his splendid and unremitting work in the past eight or nine years in compiling statistics and following them continuously.

The statistics cover a period of almost 20 years and include more than 3,000 proved cases of acute appendicitis, and represent all cases of appendicitis occurring, whether simple, appendicitis with local peritonitis, appendicitis with abscess, with diffuse peritonitis, or with progressive fibropurulent peritonitis (Tables I and II).

# ACUTE APPENDICITIS

TABLE I

ACUTE APPENDICITIS AT THE PRESBYTERIAN HOSPITAL \*

JANUARY 1, 1916, TO NOVEMBER 1, 1935 (19 YEARS AND 10 MONTHS)

Total number of cases	3,058	144 died	Total death rate	4 70%
Group I —Simple acute appendicitis				
	1,375 cases	7 died	death rate	0 50%
Group II —Acute appendicitis with acute local peritonitis				
	752 cases	15 died	death rate	1 99%
Group III —Acute appendicitis with peritoneal abscess				
	632 cases	63 died	death rate	9 96%
Group IV —Acute appendicitis with acute diffuse peritonitis				
	357 cases	60 died	death rate	16 80%
Group V —Acute appendicitis with progressive fibrinopurulent peritonitis				
	26 cases	22 died	death rate	84 61%

\* In determining the total mortality rate for all the groups, these same cases, in which more than one lesion was present, were counted only as one case, and, if the patient died, only one death was recorded. This accounts for the fact the total of the individual groups (i e , 3,142) is greater than the total number of cases (i e , 3,058)

TABLE II

PROGRESSIVE FIVE YEAR AVERAGES FOR THE LAST FIVE PERIODS

1927-1931	1928-1932	1929-1933	1930-1934	1931-1935
Total cases of acute appendicitis				
4 40%	4 08%	3 56%	3 52%	2 55%
Simple acute appendicitis				
0 72%	0 73%	0 44%	0 21%	0 21%
Acute appendicitis with acute local peritonitis				
1 34%	1 03%	0 50%	1 82%	1 14%
Acute appendicitis with peritoneal abscess				
10 63%	12 84%	12 69%	10 89%	8 96%
Acute appendicitis with acute diffuse peritonitis				
17 94%	17 44%	16 27%	14 77%	12 98%
Acute appendicitis with progressive fibrinopurulent peritonitis				
100 %	100 %	85 71%	83 33%	60 %

One of the important factors in lowering mortality is the fact that the recognition of appendicitis by the clinician sending the case into the hospital is unquestionably better now than it was 20 years ago. He thought that physicians generally were prescribing catharsis less frequently for abdominal pain than formerly, and that the use of fluids before and after operation had resulted in tremendous improvement in the results during the last decade. Another factor responsible for the improved figures in his 20 year series, he said, is the fact that cases are drained less than formerly, or, at least, are drained more intelligently.

## REFERENCE

- <sup>1</sup> Schullinger, Rudolph N. Acute Appendicitis and Associated Adhesions. Arch Surg, 32, 65-98, January, 1936

DISCUSSION —DR FENWICK BEEKMAN (New York) discussed mortality from the standpoint of acute appendicitis in children, and stated that 12 years

ago he published a small series of cases from the Children's Surgical Service at Bellevue Hospital, of children up to 12 years of age. In that series, there was a death rate of 7.58 per cent, the children under five, however, giving a mortality of 25 per cent. Fortunately, however, the number of children under five who develop appendicitis is small. To compare with this series Doctor Beekman offered statistics on the mortality for the last 11 years and 10 months, which show a decrease of two per cent, that is, from 7.58 to 5.6 per cent. He felt rather proud of this improvement, until he commenced to analyze the mortality rate by individual years, and found there was no uniform improvement in mortality (Table I).

TABLE I

## MORTALITY PER CENT BY YEARS

1924—7 %	1930—5.8%
1925—8.4%	1931—5.2%
1926—3.8%	1932—6.8%
1927—1.5%	1933—9 %
1928—3.4%	1934—2.2%
1929—5.6%	1935—7.1%

When a series comprises only a small number of cases, one or two deaths change the mortality percentage markedly, so that the only way, really, to quote mortality rates is to study large numbers of cases. Reports from individual hospitals from year to year do not mean much. The only way in which the question may be judged is from the study of large groups of cases. Children over five years of age are the most gratifying patients to operate upon for appendicitis, because their reaction is prompt. In younger children, however, under five, in whom the condition is not so easily recognized, a perforation often occurs before the disease is recognized. The peritoneum in young children does not tend to localize the infection, instead, a diffuse peritonitis is produced and, consequently, the mortality is very high. It is in these cases especially that pediatricians must be taught to recognize the condition early and before prescribing catharsis. The mortality in many children under five can be traced to catharsis having been given either by the parents or the physician who has been called in.

DR HENRY W CAVE (New York) said that at the Roosevelt Hospital the McBurney incision had been employed in practically every case of acute appendicitis, both male and female, since about 1887, when McBurney first used it at that hospital, the reason for so doing being the belief that it has lowered mortality. To substantiate this, Doctor Cave referred to a contribution in 1935 by Dr. Mont R. Reid of Cincinnati in which he stated that in a study of over 2,000 cases of acute appendicitis operated upon, "there has been a decrease of 50.3 per cent in the mortality rate since the operative procedure was changed from a rectus to a McBurney incision."

The operation for appendicitis may be easy to perform, or again, it may be most difficult, a great majority of young surgeons coming out from hospitals each year get the impression that it is a house surgeon's job, this is in itself a pernicious thing, and he thought it was undoubtedly one of the reasons for the high mortality in this disease.

The advantages of the McBurney incision over the right rectus incision were

(1) There is less chance of spreading the infection, for it seems easier to wall off, with moist tail pads, the intestines through this incision.

(2) The base of the appendix is more easily reached and grasped, and thus the appendix is brought up more readily into the wound, without disturbing the coils of the intestine

(3) As the appendix is delivered, the operator is working over on the side of the anterior abdominal wall and spilling over the side rather than back into the peritoneal cavity

(4) Better drainage is effected, for one drain can be placed down to the base of the appendix, which is well outside the usual right rectus incision, and a longer drain can be inserted down deep into the pelvis. Thus both drains are close against the right parietal peritoneum and not placed between coils of the small bowel

(5) Wound sloughing is less, for the reason that one need only sew the peritoneum around the drains in the badly infected cases. This cannot be done through the right rectus incision

(6) A lowering of the incidence of incisional herniae

DR HAROLD NEUHOF (New York) said that he could not accept, without some reservation, the views just expressed to the effect that the McBurney incision is the only one to be used if a lower mortality is to be achieved, that is so far as is referable to the technical operative procedures. Thus last year, with Doctor Arnheim, he published a paper in which two three year periods were compared. It was found that there was a very definitely lowered mortality in acute appendicitis in the second period which was ascribed to various causes. The types of incision ranged between the McBurney, muscle-splitting and other incisions, and yet the mortality was lowered. The point made was that the incision should be placed in keeping with the pathologic process. He and Doctor Arnheim could see no particular reason to be tied down to any one incision and felt that, for example, if a lesion presented high up, to make an incision low down—McBurney incision—was as illogical as to make a muscle-splitting incision high up if a mass were present low down. From their viewpoint it seemed that the essential desideratum, so far as operative procedure is concerned, is to place the incision in a logical place, over a mass.

Another point worthy of comment, he felt, was in connection with the discussion as to the status of the general peritoneal cavity in cases of spreading infection from the appendix. If one does not look all over the peritoneal cavity one does not know what type of peritonitis exists on the left side of the abdomen. In a fair proportion of cases, it must be agreed by all, precise knowledge of the status of the peritoneal cavity may prove a definite lead as to whether one should or should not operate. Some eight or nine years ago, Dr Neuof, with Dr Ira Cohen, reported the experience of several years with abdominal puncture in acute peritoneal lesions. They employed the method in order to estimate the condition of the free peritoneal cavity in acute peritoneal lesions and particularly with regard to the status of the peritoneal cavity in diffuse peritonitis due to appendicitis. If this is ascertained, one may have a guide to the decision for or against operation. The question of the existence of generalized peritonitis ought to be subjected to a method that can give precise information. Doctor Neuof could not recall in how many hundreds of cases abdominal puncture had been employed by himself and associates, but said that it is a safe and exact method of ascertaining the existence, or absence of, peritonitis, performed on the left side of the abdomen if one wishes to know whether acute diffuse peritonitis

exists After some experience has been gained with the method, puncture is found only very rarely to fail to reveal pus if it is present

DR PHILIP C POTTER (New York) thought that the task before the medical profession in lowering mortality in acute appendicitis is two-fold First, there is the need of education of the public in regard to the possible serious nature of abdominal pain, and secondly, the improvement in method of treating diffuse peritonitis The results of campaigns in the former task are encouraging The second is still under discussion, chiefly as regards the matter of immediate or delayed operation Certain arguments in favor of immediate operation make it the method of choice, in all but the exceptional case Early operation with a minimum of trauma (spinal anesthesia and McBurney incision), in Doctor Potter's opinion, not only removes the focus of infection, but establishes the diagnosis beyond dispute Diagnosis is not always certain before operation A ruptured peptic ulcer and a perforated appendix with diffuse peritonitis may give a very similar history and almost identical physical findings Cases have been encountered in which the inflammatory process has been limited to the appendix, or in which there has existed a slight degree of local peritonitis, with generalized rigidity of the abdominal wall Here, a preoperative diagnosis of diffuse peritonitis might easily, but erroneously, be made There is less drainage of the abdominal cavity which minimizes the danger of mechanical obstruction The prevailing tendency is to give more attention to the prevention of paralytic ileus At Bellevue, the endeavor is to produce a quiet intestine with normal or increased tone, but without increased peristalsis, through the use of early and repeated injections of posterior pituitary extract

DR GEORGE P MULLER (Philadelphia) brought out the point that too much time is often lost between the first visit of a patient to his physician and the second visit when he is sent into the hospital He felt that four hours should be the maximum length of time between the physician's visits in cases of suspected appendicitis He protested against the expectant treatment of these patients at home, especially in children under five years Regarding conflicting statistics about mortality rate in various parts of the country, he thought they might be due in part to a difference in the virulence of the *Streptococcus* He agreed with Doctor Neuhof regarding the desirability of making the incision over the presenting mass, and thought that, in the case of the experienced surgeon, it mattered little whether the incision was a right rectus or a McBurney incision, but that the former was dangerous in the hands of less experienced men Only with increasing experience does a man learn how to work in a hole Doctor Muller was not certain that he would care to determine the status of the peritoneal cavity by puncture



## DRAINAGE OF THE ABDOMEN \*

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IT HAS seemed to me that accepted practice in the matter of abdominal drainage is neither clear nor satisfactory, and that current surgical literature and teaching serve to obscure rather than to clarify the situation. I shall discuss very briefly, in terms of the abdomen only, some conflict in theory with an effort to expose certain illogical customs in practice, attempt to review the relation of the use of drainage materials to the theory of drainage, submit a criticism of such materials, and offer opinions on some modifications of current dogma and practice. Drainage of the abdomen seems to have remained more a matter of empiricism than of reason. A review of its history may be of interest.

Celsus,<sup>1</sup> so far as is known, first drained the abdomen for the removal of ascitic fluid. His tubes, made of lead and brass, were tapered to prevent their slipping into the abdomen and were provided with plugs to regulate the outflow. Galen<sup>2</sup> in the second century and Avicenna<sup>3</sup> in the eleventh applied this treatment for ascites, after which time no records are found of its employment until Chauliac<sup>4</sup> apparently rediscovered it in the fourteenth century. Paré<sup>5</sup> and Ryff,<sup>6</sup> in the sixteenth, Scultetus,<sup>8</sup> in the seventeenth, and Heister,<sup>7</sup> in the eighteenth century, used flanged metal tubes for the purpose of the drainage of intra-abdominal fluid. The latter is believed to have used wicks with the tubes, an early application of capillary drainage. It was, however, as a result of the ovariectomies of McDowell and his followers, and with the complications of the operation, that the problem as we know it was presented. It was found that most of the fatal cases, and some that recovered, showed a collection of serosanguineous fluid in the pelvis. It was believed that this secretion disappeared and by its absorption caused death. It was evidently desirable to remove it by some form of drainage. First, secondary drainage was attempted and accomplished through the cul-de-sac, probably first by Keith<sup>9</sup> in 1864, who also originated intraperitoneal drainage per rectum. The vaginal attack on collections of pelvic fluid has also been attributed to Peaslee<sup>10</sup> and to Sims.<sup>11</sup> About the same time Chassaignac's<sup>12</sup> introduction of the soft rubber tube furnished an apparatus which was hoped would prove effective. For a few years this measure was employed but was not satisfactory. Various attempts to secure a more adequate removal of fluid than the tube drainage afforded, were made, such as intermittent removal of fluid from the tube by suction or siphonage.

A period of multiple incision for irrigation and the insertion of drainage tubes followed. The opinion became general that drainage by the in-

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roduction of any foreign body implied local irritation, plastic exudate, and a blockage of the drainage channel Ward<sup>13</sup> found that drainage through the tubes ceased after 12 hours, and when gauze was used, in 24 hours Robb<sup>14</sup> found this occurring in from 12 hours to five days Fowler<sup>15</sup> stated that through-and-through irrigation became impossible after 36 hours Penrose<sup>16</sup> noted more variation He found one case which, at postmortem, 76 hours after operation, was free from fluid, and quotes other instances draining from three to 11 days Fowler's method of postural tube drainage was, in his own hands and in those of his associates, of distinct value Yates,<sup>17</sup> in 1905, however, completely disposed of the idea of free drainage by stating that "Drainage of the general peritoneal cavity is physically and physiologically impossible" and that "peritoneal drainage must be local and unless there is something to be gained by rendering such an area extraperitoneal or by making such an area a safe path of least resistance leading outside the body, there is aside from hemostasis, no justification for its use"

Delbet<sup>18</sup> had already, in 1889, drawn the following conclusions from animal experimentation

- (1) "The function of drainage tubes is contingent upon the obstruction of outlets by intestinal coils
- (2) "Tubes may become filled with coagula
- (3) "Capillary drains avoid this and are thus superior
- (4) "Adhesions rapidly form about aseptic drains isolating them from the general cavity
- (5) "Effective and durable drainage of the peritoneal cavity is impossible
- (6) "Serious discharge comes, in the majority of cases, from the tract about the drain"

The literature, however, of drainage for ascites cites instances of unobstructed drainage for many weeks The employment of the procedure for that condition has, however, fallen into disuse and no recent studies of its duration are available Conditions in septic infectious exudation and in ascitic transudate are not comparable It was agreed in general that drainage of the general peritoneal cavity was impossible and search for possible means to give effective, even though brief, evacuation of generalized septic fluid was abandoned

The practice of placing so called drains at, or near, the site of infection or in proximity to an area in which infection was feared or anticipated, has been continued Exactly what these foreign bodies are expected to accomplish is not always clear nor is it by any means assured that they do not often do more harm than good

It is not admitted, however, nor does it seem likely, that in all instances of intraperitoneal procedure the abdomen can be closed, undrained, without an increase in mortality, nor that drainage in itself can be as dangerous, or as deadly a procedure, as some observers suggest One doubts, indeed, if their conduct quite coincides with their vows Few of them would abandon

a more or less liberal pack which has had its advocates, from the days of Mikulicz<sup>19</sup> to those of Coffey<sup>20</sup>. A walling off by gauze or rubber dam or both, of a septic area with the avowed object of initiating an exudative reaction and starting, so to speak, a backfire against the anticipated spread of infection, they would say is not drainage but a pack.

It has been said that the peritoneum does not appreciate the difference between a pack and a drain, and it would seem that the distinction has not been accurately defined. May it be attempted? A drain is a foreign body introduced into a wound or body cavity for the purpose of removing fluid already present or the presence of which may be anticipated. A pack is a foreign body introduced into a wound or body cavity for the purpose of increasing pressure or inciting inflammation.

An ideal drain would be one which produced no exudate and caused no damage by its presence, which absorbed and removed the fluid present, or about to form, immediately, and which could be removed without trauma to the surrounding structures. We have no such absolutely ideal material, but it is possible that our methods might be improved.

The methods still employed for so called drainage of the abdomen are Glass tubes, rubber tubes, gauze wicks, cotton wicks, rubber dams, and combination cigarette drains, dressed tubes, *etc*, *etc*. Each of these has some variation from the ideals we have set for drainage material. Glass tubes, now almost obsolete, following the gold cannula of Paré into oblivion, are probably the least irritating to the tissues, but they have other drawbacks which are evident. All of them are admittedly irritating in some degree. Spellman,<sup>21</sup> in considering the selection of drainage material, discusses the changes produced in the adjacent tissues of rabbits, dogs and humans when rubber tubes and gauze drains were used. He found that rubber tubing used for drains in wounds creates a granulocytic membrane on the walls of the wound where the rubber touches it, delaying healing. The rubber tubing creates, by overstimulation of the tissue and by preventing coagulation, an excessive amount of drainage in clean wounds. He concludes that it should not be employed as a drainage material in clean wounds, but that the reaction of the tissues to rubber tubing may be an advantage in draining infected wounds. This reaction is not produced by gauze. His inference, so far as it concerns us, is that rubber placed in an infected wound, in the peritoneal cavity, retards the formation of protective adhesions because of its irritating properties. Gauze placed in the wound, however, is just sufficiently irritating to encourage the process. He does not describe the nature of the rubber tubing he used in his experiments but assures us that even rubber dam is surrounded by a thin granulocytic membrane within two days after it is placed in the wound.

Gauze, then, while the least irritating of the drains mentioned, is also unfortunately one of the less effective. Its meshes are plugged by a coagulum within a few hours and any drainage that ensues will merely burrow

along its track, so that all these methods of so called drainage appear to perform, and that rather inadequately, the office of a pack

To reiterate Yates'<sup>22</sup> dictum "Peritoneal drainage must be local and unless there is something to be gained by rendering an area extraperitoneal or by making, from such an area a safe path of least resistance leading outside the body, there is, aside from hemostasis no justification for its use"

Newell and Massingill<sup>23</sup> think that drainage is indicated when there is a large abscess cavity with shaggy necrotic edges, when bloody oozing is not controlled, after removal of a gangrenous gallbladder and in acute pancreatitis. It is evident that they are talking of what we have defined as a pack

Davis<sup>24</sup> describes his method of so called drainage after operations for appendicitis, with special reference to the most desirable time for its removal. He uses a split rubber tube with an iodoform gauze strip inside, inserted to the pelvis and a cigarette drain with an iodoform gauze center, inserted either into the abscess cavity or to the side of the pelvis. His chief concern, he says, is in the removal of the drain. In 229 cases, drains were removed after the following intervals: First day—12, second day—14, third day—54, fourth day—69, fifth day—21, sixth day—21, seventh day—5, more than seven days—2. His mortality was 11 per cent. One feels that such a procedure as this is not drainage but a form of antiseptic pack. The fluid, if any be present, is able to escape only alongside of the drainage material. The iodoform impregnated gauze is a medicated pack and its removal before it has been freed by granulations will inflict fresh trauma which may easily disseminate a previously localized process.

Two questions arise. There is no absolutely ideal drain. Is there any measurably competent method available? Is there any indication for drainage of the abdomen or may we cease making too fine a distinction and frankly confine ourselves to the proper use of a pack? I shall deal with the last question first. There are indications for the removal of fluid from the peritoneal cavity—by mechanisms directed to its removal alone. By which is meant drains that do not initiate any appreciable local reaction. These indications may be said to be

(1) The brief drainage of an early exudative peritonitis. This period in which free fluid is present may precede the wide diffusion of infection and inflammation, and the early removal of such fluid may limit the spread of infection by the disseminated exudate. There seems every reason to believe that this exudative phase varies in duration but is regularly short in so called septic cases and that a plastic phase succeeds it when drainage is futile.

(2) A prophylactic drain when, a traumatic or postoperative, exudate is anticipated. In such cases, surely, the removal of fluid is the desideratum, with no need or desire to increase its volume by irritation or dam back its discharge.

(3) A sentinel drain when a late leak, of a suture or ligature of a hollow viscus is feared.

The indications are few when compared with those calling for definite

and competent exteriorization—which means a pack, but when they are present clearly call for what we have defined as a drain

Is there any such thing? It should be highly and durably capillary. It must be completely sterilizable. It must be as slightly irritant as any foreign body can be. It must be easy to remove, without trauma, at any time.

Raffia is the split leaf of several varieties of palm, indigenous in Madagascar. It reaches our market in braided coils made up of strands from 30 to 60 inches long and from one-half to one-quarter of an inch wide. These strands present on section a basement membrane on which are laid a single layer of cell chambers, empty, of course, in the dry state and communicating with one another. It is very strong, having weight for weight a greater tensile strength than steel. Its single strand has a marked capillarity and in multiple strand wicks this action is of course proportionately increased. It resists fractional sterilization without any great loss of its strength. It is smooth and easily removed in a hank or strand by strand without trauma. It is tolerated by the tissues and produces less irritation and exudate by its presence than rubber or cotton. It has a much greater capillarity, and hence is more capable of removing exudate, than silk. It does not plug up but remains capable of capillary drainage indefinitely. It is so durable that it is used, for that reason, by gardeners to tie rose plants to sticks, where it resists the weather and long outlasts cotton or hemp. It is so immediately absorptive that it is used for extemporaneous dyeing and weaving into colored mats in kindergartens. It is easily obtained, and is cheap, two dollars' worth should supply an operating room for a year.

*Technic of Preparation*—Selected strands are chosen, cleared of straggling fibers, washed in boiling soap and water, cut into standard lengths, knotted in hanks of 20 strands and wrapped in muslin packages. These are then sterilized on three successive days and set aside for use. Before using, the needed number of strands are placed in the instrument sterilizer and reboiled. The raffia is often used alone, when it acts as nearly like a perfect drain as any mechanism we have been able to find. It may be used also in combination with more irritating material when it is desired to use a pack without incarcerating the fluid.

The raffia dressed tube is the most called for of these combinations, and allows the prompt drainage of fluid. It is apparently very effective when indicated. It has been employed in several hospitals during the past 20 years, and its use not only suggests, but clearly exemplifies, what I think surgery has been losing sight of, namely, the distinction between a drain and a pack.

#### CONCLUSIONS

Confusion has existed, and still exists, as to the essential difference between drainage and tamponade. This is fatal to a reasonable consideration of the indications for either, and is particularly true, as the record will show, in dealing with the surgery of the abdomen.

It is suggested that the natural history of so called septic peritonitis is

insufficiently understood, and that attempts to prove preconceived opinions, by means of experiments on dogs, have displaced open minded observation of disease in man

Most modern attempts at so called drainage of the abdomen are classified as superstitions and inefficient packing

It is believed that a limited field remains for abdominal drainage as defined, and a new material is offered

A field for intelligent packing is recognized

A plea is made for more intensive and detailed study of so called septic peritonitis in man

#### REFERENCES

- <sup>1</sup> Celsus De Medicina, lib vii, cap xv
- <sup>2</sup> Galen Quoted by Robb
- <sup>3</sup> Avicenna Quoted by Lande
- <sup>4</sup> Chauliac Traite des apothemes Exitures et Pustules, 1672
- <sup>5</sup> Pare Les oeuvres de M Ambroise Pare Paris, 1575
- <sup>6</sup> Ryff Gross Chirurgie, etc, Frankfurt a/M, 1569
- <sup>7</sup> Heister Chirurgie in welcher alles was zur Wundartzney, etc, 1719
- <sup>8</sup> Scultetus Armamentarium Chirurgicum, 1741
- <sup>9</sup> Keith Peaslee, Ovarian Tumors, 509, N Y, 1872
- <sup>10</sup> Peaslee Ovarian Tumors, 509, N Y, 1872
- <sup>11</sup> Sims N Y Med Jour, 16, 561, 1872, 17, 360, 1873
- <sup>12</sup> Chassaignac Traite pratique de la Suppuration Paris, 1, 152, 1859
- <sup>13</sup> Ward JAMA, 27, 199, 1896
- <sup>14</sup> Robb Johns Hopkins Hosp Rep, 2, 184, 1890
- <sup>15</sup> Fowler N Y Med Rec, 57, 617, 1900
- <sup>16</sup> Penrose (J Price) Trans Amer Assn Obst and Gynec, 1, 10, 1888
- <sup>17</sup> Yates Surg, Gynec and Obst, 1, 1905
- <sup>18</sup> Delbet Amer Gynec and Obst, 33, 1000, 1890
- <sup>19</sup> Mikulicz Arch f klin Chir, 34, 635, 1889
- <sup>20</sup> Coffey, R C Amer Jour Surg, 24, 417
- <sup>21</sup> Spellman, A E Arch Surg, 28, 837
- <sup>22</sup> Yates qv
- <sup>23</sup> Newell and Massingill Jour Tenn Med Assn, 26, 285
- <sup>24</sup> Davis, C R ANNALS OF SURGERY, 99, 637

DISCUSSION —DR WM BARCLAY PARSONS, JR (New York) —The fact that drainage and packing are frequently confused, particularly among younger physicians, is exemplified almost daily on hospital rounds. If one happens to have plenty of time he can almost always start a discussion on "Why did you do so and so?" in a particular case, or "Why did you drain that case?" or "Why haven't you taken the drains out?" If there are five men, they are very apt to give five different opinions as to the proper way of draining an appendix or gallbladder and as to why not to drain one, or to drain the other. The distinction between packing and draining is something to be carefully considered.

DR DONALD GORDON (New York) —What is the reaction of plain serum upon this material? A good many years ago he had used what is now called

cellophane, for abdominal drains, and thought it an excellent material, that was before he found out that it was a biologic membrane and that, if there was considerable exudate, this would permeate and coagulate on the cellophane thus preventing drainage. Might not that take place in raffia?

DR SEWARD ERDMAN (New York) —What is the possible danger of one of the strands slipping through the tubing during the removal of the drain? It would seem as if a drain, made up of so many small and slippery strands, would be rather dangerous in the abdominal cavity.

DR JOHN E. JENNINGS (Brooklyn, N. Y.) closing —Emphasized the fact that the material described, raffia, has a capillarity superior to that of ordinary gauze mesh or other wicks. It is very much less irritating and does not plug up as does the wick of gauze. It may be left in as long as desired. Doctor Jennings said he had left it in wounds for three or four weeks and had then been able to withdraw it, strand by strand, without even the patient's knowledge of its being done, and without trauma. He has never used antiseptics with it. Occasionally, he has used it in association with iodoform gauze as an adjunct to packing. He again stressed the fact that drainage is not the same as packing. Histologic studies show that, with packing, one uses a foreign body which causes local reaction. If one packs, it should be done with intent, so that the fluid one is dealing with will not break through. Raffia is the result of an attempt to find a drainage material with sufficient capillarity, which is not irritating and which will remove fluid, without creating more.

The insertion of a cigarette drain, where no drainage is indicated, should be abandoned. If drainage is needed, the drain should be raffia or something more like it than a cigarette drain and, if packing is desired, no half-way measure like a cigarette drain should be used.

Raffia, in its crude state, may be obtained from any seedsman or dealer in horticultural supplies.

# EXPERIMENTAL STUDIES IN CAROTID-JUGULAR ANASTOMOSIS\*

WITH SPECIAL REFERENCE TO THE RÔLE OF THE CAROTID SINUS

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ALTHOUGH the effects of arteriovenous communication on the circulation have been well understood for some time, anastomosis of the carotid artery and jugular vein presents, however, a special problem which we have felt worthy of study. The recent discovery of the importance of the carotid sinus as a systemic blood pressure regulator made it seem likely that fistulae in this region would differ somewhat in their effects from those elsewhere. Clarification of this point gains added importance in that end-to-end carotid-jugular anastomosis has been advocated as a therapeutic procedure.

The conflicting observations, and the divergent speculations of clinicians concerning traumatic arteriovenous fistula or "aneurism" have been reviewed by Holman<sup>8</sup> and need not be discussed here. Experimental fistulae were successfully made in dogs in 1907 by Cannel<sup>1</sup> but no attempt was made to study the postoperative circulatory adjustments until, in 1920, Reid<sup>4</sup> published his findings on experimental fistulae. These studies had been stimulated by a previous series of experiments<sup>2, 3</sup> and in them attention was centered on vascular changes. Although the results of the 12 anastomoses, performed by Reid,<sup>4</sup> were not altogether consistent, Dog 9, which survived with an open carotid-jugular fistula for two years, developed a definite dilatation of the proximal artery as well as cardiac dilatation and hypertrophy, similar to some human cases. These studies were then continued by Holman, who, in 1923,<sup>8</sup> formulated the conception of the readjustments of the circulatory system to an open arteriovenous fistula which is now generally accepted. In 1924, he wrote, or collaborated, in five papers<sup>9, 10, 11, 12, 13</sup> in which he reviewed previously reported cases, and thoroughly studied the physiology resulting from these fistulae.

This conception is briefly, as follows. Blood pressure is normally maintained by (1) the rate of blood flow per minute (cardiac output), (2) the total volume of blood, (3) the capacity of the circulatory system, and (4) the peripheral resistance. The main effect of arteriovenous fistulae is to alter the last of these. This alteration is large or small depending upon the size of

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\* A preliminary report of this work was read before the Philadelphia County Medical Society, March 27, 1935. Submitted for publication March 17, 1936.



the fistula and its nearness to the heart. Since alterations in the capacity of the vascular bed can compensate only temporarily for the decreased resistance, permanent compensation must take place through alterations (increases) in the cardiac output and blood volume. The degree of these compensatory increases depends on the amount of blood which is short circuited through the fistula, which in turn depends upon the size of the fistula. Thus divergent findings can be explained by the fact that the fistulae were of different sizes. If the diameter of the fistula is no larger than that of the proximal artery, dilatation of that artery and cardiac dilatation are not great. If, on the other hand, the fistula is larger in diameter than the proximal vessel, that vessel dilates until the resistance it offers to the flow of blood through it is no greater than that offered by the fistula. In such cases both blood volume and cardiac output must greatly increase, and cardiac dilatation and hypertrophy follow.

In 1923, coincident with Holman's work, Lewis and Drury<sup>6</sup> published studies of two patients with old traumatic fistulae, commenting on the analogy with aortic regurgitation. In experimental studies, published a few months later,<sup>7</sup> they showed that the systolic blood pressure might rise, following its initial drop on opening the fistula, to even higher than its normal figure. Hoover and Beams<sup>14</sup> reported some clinical cases in 1924, distinguishing between true decompensation and the cardiac signs associated with fistulae. They also describe experiments in which bilateral 7 Mm carotid-jugular anastomoses were made in dogs. Using a mercury manometer, they report no change in pulse or blood pressure on opening and closing the fistula six months later.\* Reid's three articles,<sup>15, 16, 17</sup> published in 1925, call attention to the essential similarities of all abnormal arteriovenous communications. None of these observations, however, alter Hoeman's fundamental concept.

It is surprising, therefore, to find Babcock,<sup>18</sup> in 1926, advocating the establishment of end-to-end carotid-jugular anastomosis as a treatment for aortic aneurysm. The rationale of this procedure depends on the assumption that the expansion of an aneurysm is due to the pressure on its wall. To produce a lowering of pressure in the aneurysm, Babcock feels that an arteriovenous fistula beyond it is an effective means. This treatment has, since that time, been used by him and McCarthy, with what is said to be considerable success, though no extensive series has yet been reported. Furthermore, no experimental studies of this type of fistula have been published, except those done by Winslow and Walker,<sup>20</sup> in which blood pressure alone was studied, and from which it is difficult to draw positive conclusions.

**EXPERIMENTAL PROCEDURES**—The anastomoses were performed upon dogs under nembutal anesthesia (30 mg per kilo) with rigid aseptic blood vessel technic. All the wounds healed by primary union, and after subsidence of the initial edema, a marked continuous thrill with systolic accentuation could easily be felt. There was no evidence of cerebral anemia following

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\* Since these findings are inconsistent with those of all other workers, it seems probable that these fistulae had practically closed, as is often the case.

operation The size of the vessels and of the fistulae was measured at operation and again at the time of excision or necropsy

The experimental studies have been divided into four groups Group I—Studies of changes in the heart and aorta Group II—Studies of changes in cardiac output Group III—Studies of changes in arterial blood pressure Group IV—Some observations on the rôle of the carotid sinus

#### GROUP I—STUDIES OF CHANGES IN THE HEART AND AORTA FOLLOWING CAROTID-JUGULAR ANASTOMOSIS

*Method*—Changes in the size and shape of the hearts of six dogs were determined roentgenologically at intervals after the establishment of end-to-

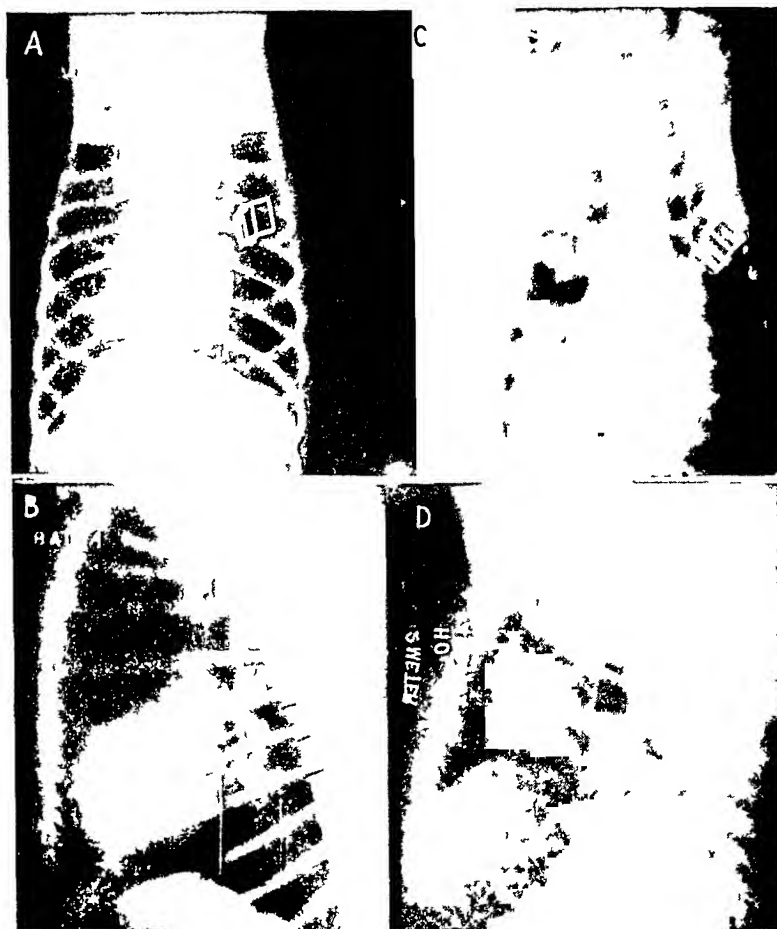


FIG 1—Roentgenograms of the heart of Dog 5, before and 14 months after the formation of an 8 Mm carotid-jugular fistula (A) Antero-posterior, before operation (B) Lateral, before operation (C) Antero-posterior after 14 months of open fistula (D) Lateral, after 14 months of open fistula

end or side-to-side carotid-jugular fistula The degrees of dilatation and hypertrophy were determined at autopsy The roentgenograms were made at a tube distance of six feet, and with an exposure time just exceeding that of the cardiac cycle At autopsy the hearts were weighed after evacuation of the contained blood One of them was injected in situ with barium, in an attempt to demonstrate hypertrophy of the ventricular walls, in comparison with a similarly injected heart of a normal dog of comparable size and weight

*Experimental Observations*—Enlargement of the cardiac shadow regularly followed the formation of both types of carotid-jugular fistulae. These characteristic changes are shown in Figure 1. That most of the increase in size of the cardiac shadow is due to dilatation is indicated by the results of barium injection (Fig. 2). Although differences in thickness of the heart walls cannot be detected roentgenologically, this dilated heart (dog's body weight 14 kilos) weighed 19 grams more than that of the control animal (body weight 19 kilos).

Further evidence of hypertrophy of the cardiac muscle is given by the

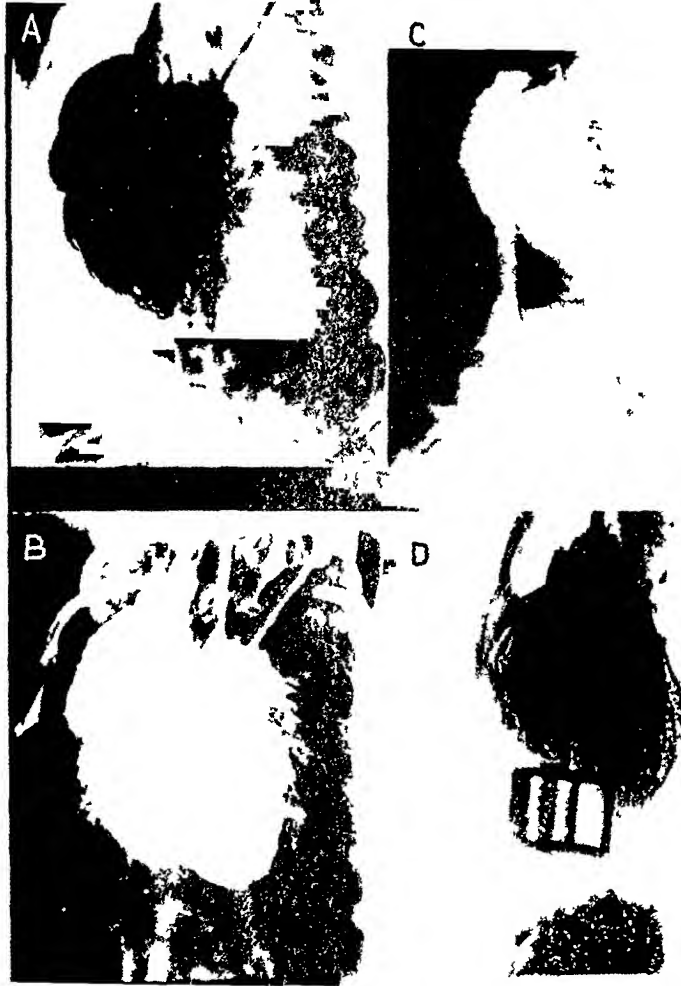


FIG. 2—Roentgenograms of the hearts of two dogs, two meter tube distance following injection of the heart chambers with barium. (A) Dog 4, weight 14 kilograms, three months after formation of fistula, right cardiac chambers injected. (B) Same dog, remaining chambers injected. (C) Normal dog, weight 19 kilograms, right cardiac chambers injected. (D) Same dog, remaining chambers injected.

weight at autopsy of the hearts of four other dogs (Table IV). Assuming the ratio of 7.5 grams heart weight per kilogram of body weight as normal (which seems generous on the basis of control figures of Holman and our observations), our series showed an average increase in heart weight of 48 per cent. Applying the same ratio to Holman's series of eight dogs with femoral and iliac fistulae,<sup>12</sup> there was an average increase in heart weight of only 16 per cent, in spite of the fistulae in his series averaging three times as large.

Since dilatation and thinning of the walls of the ascending aorta and carotid artery proximal to the fistula were noted in most of these animals at autopsy, studies of aortic size were made on two additional animals during life. The aorta was studied by attaching two silver clips on opposite sides of the aorta and a third anteriorly between them in a plane just distal to the aortic valve. Direct measurements of the distance between these clips could then be made on roentgenograms taken at a distance of six feet, with an exposure time covering the cardiac cycle. It may be seen from Figure 3 that there is no change in the distance between the clips in the control animal,

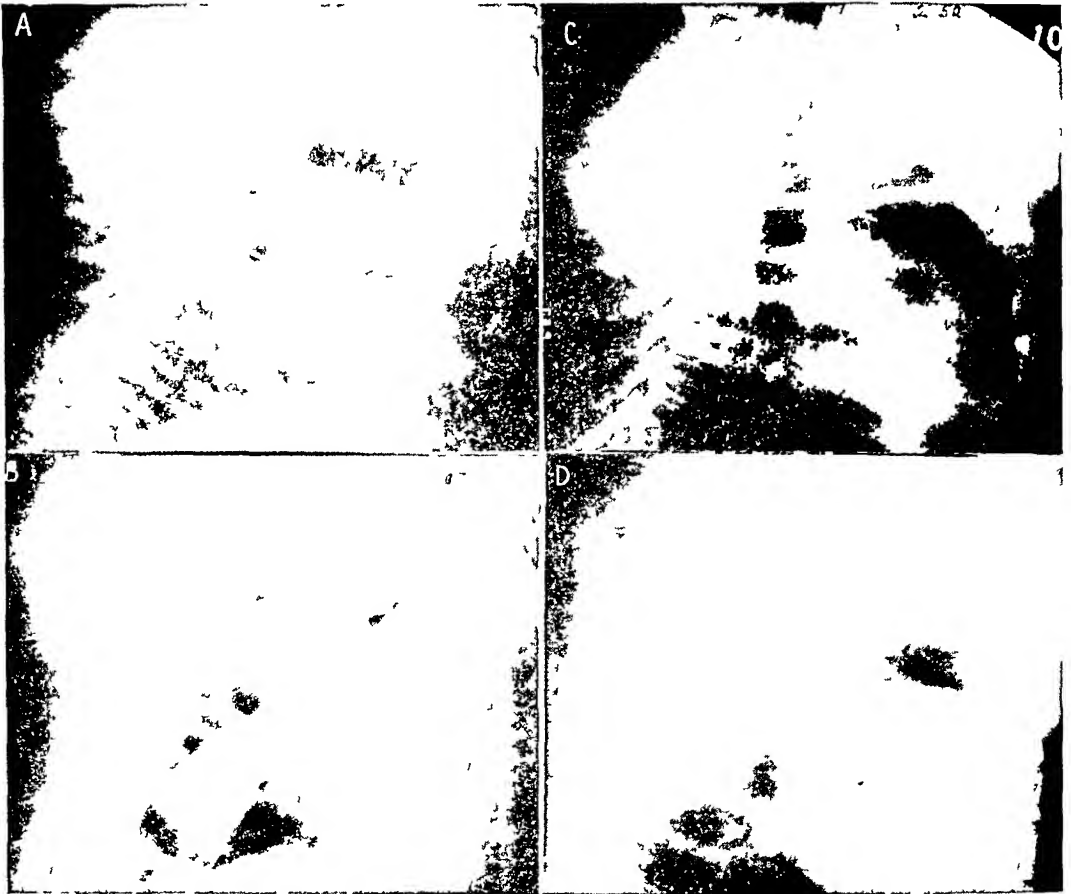


FIG 3—Roentgenograms of two dogs following the attachment of silver clips to the aorta. (A) Normal dog. (B) Same dog later—the distance between clips agrees within 1 Mm. (C) Normal dog before formation of fistula. (D) Same dog four months after formation of an 8 Mm. end-to-end fistula, there is an increase of 4 Mm. between the clips.

in the experimental animal the change is obvious (4 Mm. by actual measurement).

COMMENT—These heart and blood vessel changes are so conspicuous that their presence in human cases has been known for many years. As long ago as 1850 Baker<sup>24</sup> described them accompanying a varicose aneurism of the profunda femoris artery at its origin. He relates "the heart was greatly dilated in all its cavities, walls hypertrophied, ascending aorta dilated, communicating aperture one inch in diameter." They were observed by Reid<sup>1</sup> following his experimental fistulae, and he made a thorough gross and microscopic study of the degenerative changes in the vessels. It has not seemed

to us necessary to study these heart and vessel changes in our series in great detail, but merely to demonstrate their presence and degree

## GROUP II—STUDIES OF CHANGES IN CARDIAC OUTPUT FOLLOWING CAROTID-JUGULAR ANASTOMOSIS

*Method*—Fifty-one determinations of cardiac output were made on six dogs before, and at varying intervals after the establishment of carotid-jugular anastomoses, and after excision of the fistulae. Under Nembutal anesthesia\* the dogs were connected by means of a specially constructed conical rubber mask, with a closed respiratory system including soda-lime scrubber for removing carbon dioxide, inspiratory and expiratory flutter valves, and a Benedict spirometer. They breathed pure oxygen, and oxygen absorption per minute was determined by measurement of the respiratory tracing for periods of eight to ten minutes. A sample of mixed venous blood was obtained before disconnecting the animal, by puncture of the right ventricle, and a sample of arterial blood by puncture of the femoral artery. The oxygen content of these samples was determined by the manometric method of Van Slyke and Neill, and the cardiac output determined according to the Fick formula.

*Experimental Observations*—The animals may be considered as three groups of two dogs each. Dogs 1 and 2 had end-to-end carotid-jugular anastomoses established two years before these experiments were begun. Determinations were, therefore, made before and after excision of the fistulae (Table I). The fistulae were found, upon excision, to have shrunk to a

TABLE I

	Dog 1				Dog 2			
	Oxygen	Arteri-	Oxygen	Cardiac	Oxygen	Arteri-	Oxygen	Cardiac
	Capac-	ovenous	Consump-		Capac-	ovenous	Consump-	
	ity	Differ-	tion	Output	ity	Differ-	tion	Output
	Vol %	Vol %	Cc per min	Cc per min	Vol %	Vol %	Cc per min	Cc per min
End-to end	26.2	3.0	120.0	4.000	23.9	4.2	92.8	2.210
Fistula	24.6	3.8	173.3	4.561	21.4	4.2	72.8	1.734
Open	24.0	3.1	114.9	3.705	20.0	3.2	97.8	3.056
					20.3	3.5	111.2	3.177
					20.4	3.9	101.5	2.602
After	21.8	3.6	126.1	3.503	19.4	2.6	94.8	3.646
Excision	27.5	4.4	209.1	4.752	19.9	3.2	62.3	1.947
of Fistula					20.6	2.6	66.2	2.546

diameter smaller than that of the normal carotid artery in both animals. Perhaps because of the large individual variations, no difference in cardiac output before and after excision of the fistula was evident. A small increase would be expected and might be demonstrable by a more accurate method.

\* The earlier determinations were made without anesthesia other than a small amount of morphine (four mg. per kilo), but some of the dogs were found to be very difficult to train properly. Subsequently the output of trained animals was determined with and without nembutal anesthesia, and since no significant differences were noted, the remainder of the experiments were done using this anesthetic (30 mg. per kilo).

TABLE II

	Dog 3				Dog 4			
	Oxygen	Arteri-	Oxygen	Cardiac	Oxygen	Arteri-	Oxygen	Cardiac
	Capac- ity	ovenous Differ- ence	Consump- tion		Capac- ity	ovenous Differ- ence	Consump- tion	
	Vol %	Vol %	Cc per min	Cc per min	Vol %	Vol %	Cc per min	Cc per min
Normal control	21.7	3.5	112.5	3.214	17.0	3.0	115.3	3.845
	15.9	2.9	110.0	3.798	14.5	2.4	101.4	4.225
	16.0	2.7	100.3	3.716	16.3	3.0	92.2	3.073
After end-to end anastomosis	15.1	1.5	108.8	7.256	17.4	1.1	103.6	9.418
	15.0	2.6	80.0	3.084 *	17.5	1.8	88.7	4.928 †
	15.6	1.0	97.3	9.730				
	16.4	1.1	89.9	8.172				

\* Fistula had closed spontaneously

† Fistula had almost closed

Control determinations were made on Dogs 3 and 4, and large end-to-end fistulae were then established. Further determinations were made at varying intervals thereafter (Table II). One week after an 8 Mm fistula had been made, the cardiac output of Dog 3 had increased 125 per cent. Yet five months later, his fistula had closed spontaneously, and his output was the same as in the control period. A 15 Mm anastomosis was then established, and three weeks later his output had increased 212 per cent. A month later, it was still more than twice its original value. Similarly, the output of Dog 4 increased 153 per cent in two months after the establishment of an 8 Mm fistula. Both these dogs became emaciated and mangy in spite of special diet and care, but when a month later the condition of Dog 4 had obviously improved, it was found that his output had fallen to only 32 per cent above normal, and autopsy revealed that the fistula had shrunk to 3 Mm in diameter. If the animal had been allowed to survive, the fistula would have probably closed as it did in Dog 3, or a condition would have been attained similar to that in Dogs 1 and 2, where no increase in cardiac output was demonstrable by the prevailing methods.

TABLE III

	Dog 5				Dog 6			
	Oxygen	Arteri-	Oxygen	Cardiac	Oxygen	Arteri-	Oxygen	Cardiac
	Capac- ity	ovenous Differ- ence	Consump- tion		Capac- ity	ovenous Differ- ence	Consump- tion	
	Vol %	Vol %	Cc per min	Cc per min	Vol %	Vol %	Cc per min	Cc per min
Normal control	15.9	4.6	118.9	2.582	23.0	3.2	85.3	2.666
	17.7	3.7	92.9	2.511	22.0	4.1	93.1	2.270
	18.0	4.2	104.4	2.485	22.2	3.6	69.3	1.925
After side to-side anastomosis	17.0	1.9	126.5	6.657	19.9	2.8	96.9	3.462
	20.4	3.3	146.5	4.441	20.6	1.7	79.3	4.667
	20.4	2.3	133.6	5.808	21.2	2.2	126.1	5.733
	19.4	2.2	115.0	5.227	21.1	2.5	115.7	4.628
After Change to end-to end anastomosis	18.5	2.8	186.2	6.650	19.3	2.5	150.0	6.015
	20.2	2.5	209.5	8.380	17.3	3.3	179.0	5.427
	18.1	3.1	204.9	6.612	17.7	2.3	125.6	5.464
	14.7	1.5	197.5	13.166				
Fistula excised	16.4	1.6	176.8	11.048				
	19.9	1.4	127.6	9.112	14.7	4.1	100.3	2.447
	18.4	2.6	135.8	5.224	17.0	6.0	118.5	1.975

The observations on Dogs 5 and 6 are shown in Table III. After the control determinations had been obtained, 7 Mm side-to-side anastomoses were made, and the dogs' output followed for some months, the anastomoses were then changed to end-to-end by dividing and closing the distal vessels, and further determinations were obtained, finally, the fistulae were excised and the outputs again determined. In both cases the side-to-side anastomosis was followed by a marked increase in output. In Dog 5 the average of four determinations done during three months after operation showed an increase of 115 per cent over the control average. Similarly the average increase in Dog 6 was 91 per cent during two months.

After the change to an end-to-end anastomosis, Dog 5 showed an average increase of 185 per cent in the course of eight months, during which time he became emaciated and mangy, as was noted with Dogs 3 and 4. The condition of this dog, however, then became rapidly worse, in spite of every effort to improve his condition, and during the next two months the fall in oxygen capacity of the arterial blood indicates that an anemia existed which further increased his output to enormous figures—an increase of 421 per cent being found on one determination. Since it appeared that a vicious circle existed (the anemia making the enormous output imperative, and the strain of maintaining this output preventing improvement in his anemia) which would soon have resulted fatally, the fistula was then excised. His improvement was immediate, but the output did not immediately fall to the control figures (since anemia still existed), two weeks later having fallen to 260 per cent above the control, and a month later to 106 per cent. At this time a coronary artery was wounded in obtaining the venous blood sample and the dog died before the output had returned to normal.

The reaction of Dog 6 was not so severe. An average increase of 123 per cent over the control output was found on three determinations done eight, nine and ten months after changing the side-to-side to an end-to-end anastomosis, as compared to 91 per cent before the change. His condition remained good throughout the 15 months of experiment. Determinations made one and two months after excision of the fistula were in the same range as the normal controls.

COMMENT—These results are in agreement with those of Holman in his studies of femoral and iliac fistulae, differing only in degree. These carotid-jugular fistulae resulted in increases which were well over 100 per cent in contrast to the average of 78 per cent in Holman's series of dogs with fistulae approximately three times as large. The apparently greater tendency of end-to-end fistulae to close, or to shrink to a size so small that their influence on cardiac output is not apparent, has been noted by other workers. This appears to be their only difference from side-to-side fistulae.

#### GROUP III—STUDIES OF CHANGES IN ARTERIAL BLOOD PRESSURE FOLLOWING CAROTID-JUGULAR ANASTOMOSIS

*Method*—Determinations of blood pressure in the femoral artery were made in six dogs before the formation of both types of carotid-jugular fistu-

lae, and at varying intervals thereafter. In four of the animals additional determinations were obtained after excision of the fistulae.

The creation of a communication between the carotid artery and the jugular vein, with its accompanying effects of increased heart rate, high pulse

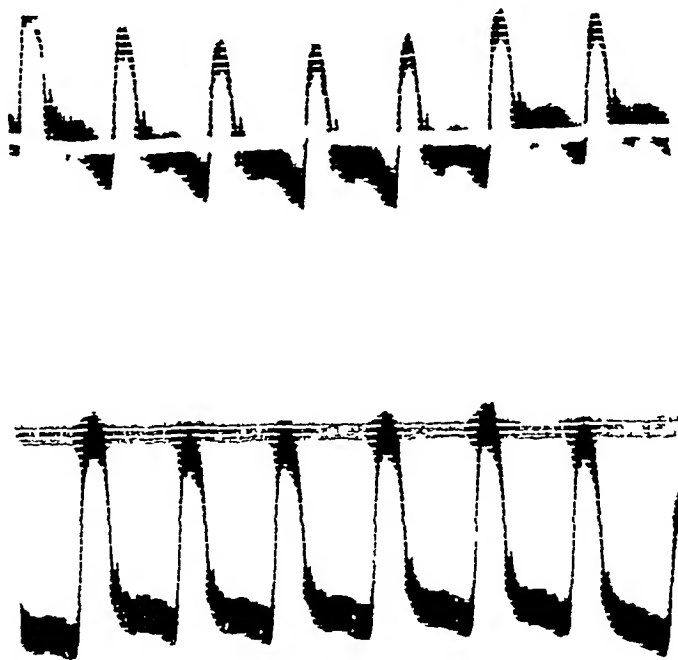


CHART 1—Above Photomanometric tracing from the ascending aorta of a normal dog. Below Photomanometric tracing from the ascending aorta of a dog nine and one-half months after the formation of a carotid-jugular fistula.

pressure, and the collapsing quality of the pulse wave, make the choice of a blood pressure registering device a most important one, particularly when the artery must be preserved for repeated determinations. The pressure wave characteristics in the presence of a carotid-jugular fistula in contrast

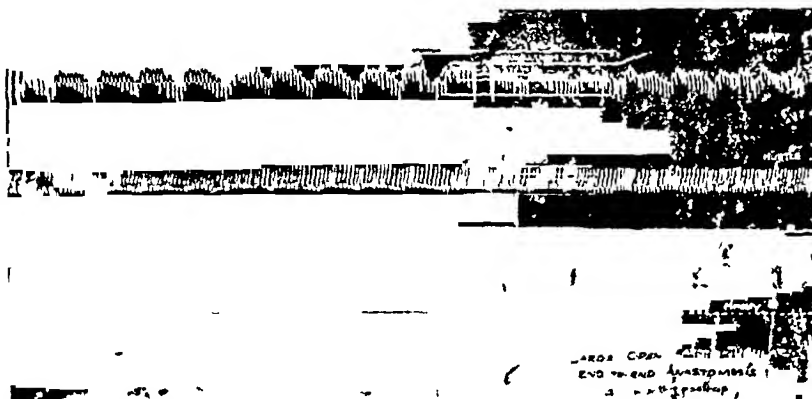


CHART 2—Kymographic tracings from the cannulated femoral artery of Dog 4 four and one-half months after the formation of an end-to-end carotid-jugular fistula. Above Using a mercury manometer, giving a reading of 165/150. Below Using a Hürthle manometer, giving a reading of 200/140.

to the normal are shown in Chart 1. The high pulse wave with diminished diastolic and postdiastolic waves noted in the lower tracing are outstanding. Failure of the mercury manometer to register true values in animals with



fistulae becomes obvious in Chart 2, where the mercury manometer, because of its inertia, fails to reveal the high pulse pressure of 60 millimeters in this animal

After carefully evaluating the advantages and disadvantages of the current methods of blood pressure measurement, we devised, following the suggestion of Dr. Kenneth Cole, the simple instrument illustrated in Figure 4

*Technic*—After assembly and testing for air tightness, an anticoagulant fluid is aspirated into the instrument up to the zero mark on the scale. The stop-cock is then closed and the instrument is ready for use. After piercing the skin, the level of anticoagulant fluid is carefully noted before the needle is inserted into the artery. After insertion, the highest excursion of the blood-tinged fluid is noted as systolic pressure, and the lowest recession as diastolic. The needle is then withdrawn and inserted through the wall of a rubber tube filled with water and connected with a reservoir and mercury

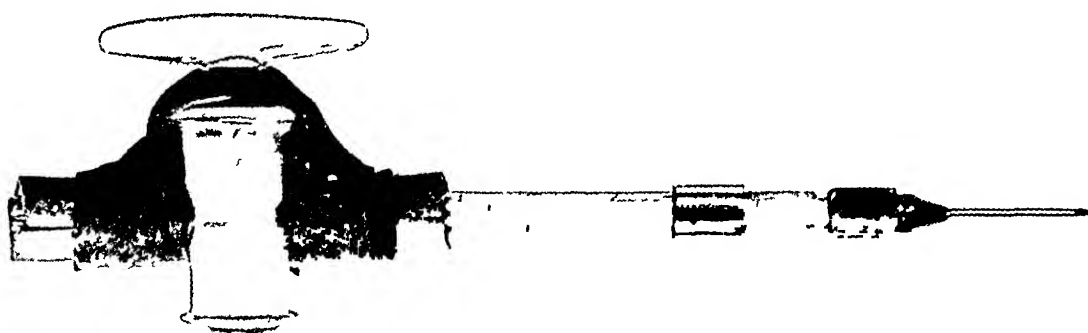


FIG. 4—An instrument for direct blood pressure measurement. It consists of a blood pipette of 1 Mm. bore, shortened the tip ground to take a Luer needle and the cylinder graduated in millimeters. The 18 gauge needle is 3 cm. long, with a short, rounded bevel and a sharp point. The sliding metal cuff facilitates more accurate readings.

manometer. By raising the pressure in this system, that necessary to return the fluid to the points noted as systolic and diastolic pressure can be read off directly on the manometer.

It is important that no air be allowed to enter the needle during the transfer from artery to tube, and that the level of fluid in the instrument at the moment of insertion into the tube be the same as at the moment of insertion into the artery. It is also essential that no change of temperature occur in the air contained in the instrument. Such change can be minimized by partially covering the instrument with a piece of split rubber tubing, and by making the reading immediately after withdrawal of the needle from the artery.

This method is a direct one, which neither sacrifices the vessel, nor materially obstructs the flow of blood through it. It is sensitive, and registers quick changes in blood pressure comparable to a Huithle manometer, against which it has been adequately checked. Using the principle of compressing air in a narrow chamber, and taking the changed volume as an index of pressure are sufficiently accurate only so long as proper precautions are taken to prevent change in temperature and loss of fluid. The reflex effect of

painful stimuli on the blood pressure is another source of error to which this method is subject. Our experience in conditioning dogs for cardiac output studies have convinced us that the conditioned state mitigates to a remarkable extent the usual effects of pain. On thoroughly conditioned animals, the substantial agreement of readings with this instrument, with and without nembutal anesthesia, makes us confident of the accuracy of the results compiled in Table IV.

TABLE IV

THE BLOOD PRESSURE CHANGES IN SIX DOGS AFTER FORMATION OF CAROTID-JUGULAR FISTULAE, AND AFTER THEIR EXCISION, TOGETHER WITH CHANGES IN FISTULA SIZE AND HEART WEIGHT

Dog Number	1	2	3	4	5	6
Blood Pressure in Femoral Artery						
Before formation of fistula	145/75	135/70	155/105	165/120	155/95	180/105
After formation of fistula						
1-2 months			145/95		160/60	180/45
2-3 months			185/105	200/120	170/70	
3-6 months		165/60	200/140			210/70
6-12 months *					210/90	210/70
12-24 months	215/90	200/100				
24-36 months		205/100				
Change in systolic pressure	+70	+70	+45	+35	+55	+30
Change in diastolic pressure	+15	+30	+35	0	-5	-35
After excision of fistula	220/110 (1 mo)	140/70 (6 mos)		188/132 (24 hrs)		180/120 (2 mos)
Size of Fistula						
When made	5 Mm	8 Mm	15 Mm	8 Mm	7 Mm	8 Mm
When excised	3 Mm	3 Mm		3 Mm		
Weight of Dog (kilograms)	22	15	20	14	23	20
Weight of Heart (grams)	220		185	165	247	275
Increase above Normal (per cent)	35		23	55	44	83

\* Carotid sinuses denervated

*Results*—Analysis of Table IV shows that the maximum increase in systolic pressure was 70, the minimum 30, and the average 50 millimeters of mercury. There was also an increase in diastolic pressure in three of the dogs, in two the diastolic pressure returned to its preoperative level and in only one did it remain low. The pulse pressure was elevated in every case.

*COMMENT*—The systolic blood pressure following arteriovenous fistulae between vessels other than the carotid and jugular is known to regain its preoperative level frequently, but it has seldom been found to exceed it by more than a few millimeters of mercury. The highest rise, reported by Holman and Kolls,<sup>11</sup> in Dog L28, showed a ten-millimeter rise seven months after formation of a large femoral fistula. In contrast to our findings, diastolic pressure following other fistulae remained permanently lowered.<sup>7, 11</sup>

This difference in the effect on blood pressure of carotid-jugular fistulae and those between other vessels suggests that other factors in addition to those enumerated by Holman<sup>8</sup> may come into play. We have also frequently observed conspicuous capillary pulsation in these dogs, a finding which is not recorded as occurring in those with fistulae elsewhere. Lewis and Drury<sup>6</sup> have called attention to the similarity of clinical signs in arteriovenous fistulae and aortic regurgitation. Furthermore, Lewis<sup>5</sup> has presented evidence that

the primary factor in capillary pulsation is arteriolar relaxation. The significance of these observations, as evidence of carotid sinus activity, is discussed under Group IV.

#### GROUP IV—OBSERVATIONS ON CAROTID SINUS ACTIVITY IN THE PRESENCE OF CAROTID-JUGULAR ARTERIOVENOUS FISTULAE

The importance of the carotid sinuses as regulators of the systemic blood pressure, and the fact that carotid-jugular fistulae more seriously alter carotid sinus pressure than fistulae elsewhere, prompted us to make this study.

The creation of an arteriovenous fistula, as described by Holman, gives rise to two closed circulatory systems supplied by a common source, the heart, the original system (A) consisting of heart, artery, capillary bed and vein, and system (B), heart, artery, fistula and vein. Figure 5 illustrates these systems applying to carotid-jugular fistulae. The variable factors normally responsible for the maintenance of mean systolic blood pressure are (1) Peripheral resistance, (2) cardiac output, (3) total volume of circulating blood, and (4) total capacity of the circulatory system as altered by contraction or dilatation of the vessel walls.

An arteriovenous fistula, by creating a low resistance heart-artery-fistula-vein system (B), causes a marked lowering of peripheral resistance, factor 1. To maintain a normal flow through the heart-artery-capillary bed-vein system (A) there must be compensatory changes in the three remaining factors. To offset the large volume of blood lost to system (A) through the low resistance fistula system (B), there is an immediate increase in cardiac output, factor 2, and, later, an increase in the total volume of circulating blood, factor 3 (Holman<sup>10-13</sup>). Systemic vasoconstriction would diminish the capacity of the circulatory system, factor 4. Such a change would still further lessen the amount of blood getting to the tissues through system (A) and increase the proportion of flow through the fistula, system (B).

Our present conception of the reflex mechanism controlling the caliber of blood vessels, and thus varying the total capacity of the vascular system,

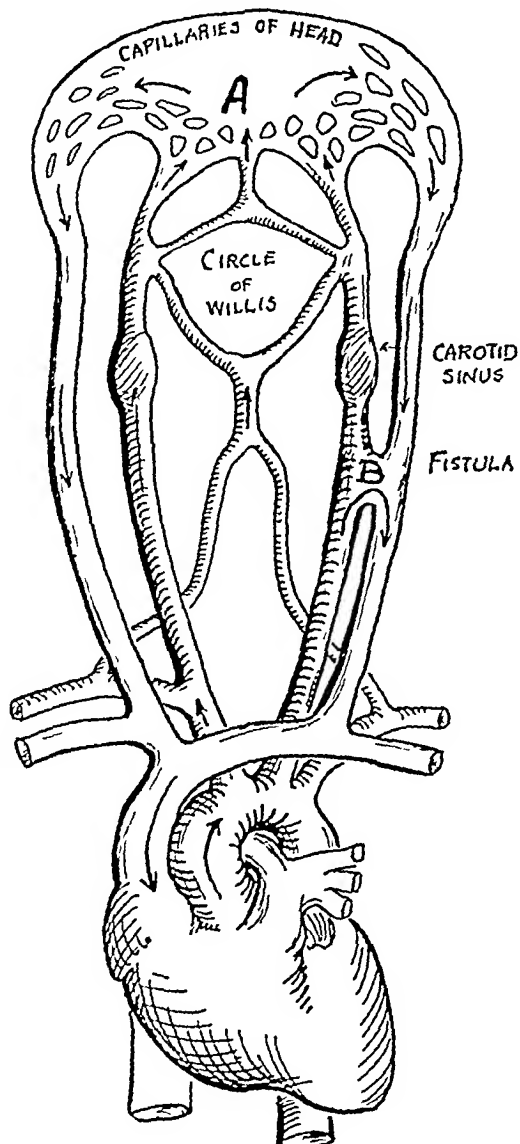


FIG 5—Diagrammatic schema, to show the relationship of a side-to-side carotid-jugular fistula to the systemic circulation and arterial anastomoses in the head.

represents the circular muscles of the arterioles in a state of constrictor tone. This tone is maintained by a continuous barrage of efferent impulses from the vasoconstrictor center, whose tone is in turn inhibited by continuous afferent impulses from special pressure receptors, located in the carotid sinuses and aorta.\*

In agreement with Schmidt,<sup>23</sup> we found that occlusion of one common carotid artery in dogs lowers the carotid sinus pressure approximately 20 per cent. Occlusion of the artery was necessary in the formation of an end-to-end carotid-jugular fistula. We postulate that this type of fistula causes initially a more severe reflex vasoconstriction of the systemic arterioles than a similar sized fistula elsewhere. A severe systemic vasoconstriction in the presence of a fistula would result in an increase in blood flow through the fistula. This is borne out by the fact (since cardiac output per minute is dependent upon venous return) that the increase in cardiac output in our dogs following carotid-jugular fistulae averaged 59 per cent greater than that reported following fistulae approximately three times as large between other vessels. We further postulate that it is the proximity of the fistula to the carotid sinuses rather than proximity to the heart that largely accounts for the universal clinical impression of the seriousness of fistulae of the carotid arteries.

Since the observations to be presented were made on two animals only, they are more suggestive than conclusive. We feel they are significant, however, because (1) each response was observed repeatedly, (2) they are in essential agreement with the findings of other workers, and (3) their interpretation is in harmony with the accepted facts concerning the reflex mechanism of blood pressure control.

*Experimental Observations*—These observations consist of kymographic recordings of blood pressure in two dogs during manipulative alterations of the component vessels of a carotid-jugular fistula, before and after denervation of the carotid sinuses. The records were made directly from Huithle and mercury manometers which had been connected with a cannulated systemic artery. Intraperitoneal nembutal anesthesia was used. The mean systolic pressures recorded have been plotted on Chart 3.

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\* Our knowledge of the carotid sinuses has recently been materially advanced by extensive and corroborative experimental work. The remarkable experiments of Bronk and Stella,<sup>21, 22</sup> in which they were able to record, acoustically and photographically, the inhibitory impulses from the carotid sinuses, added much to our knowledge of the rhythmic activity of their pressure receptors. It was demonstrated that these receptors did not all have the same pressure threshold, and that individual receptors responded with a higher frequency upon an increase in pressure. Thus a great increase in sinus pressure would not only cause more receptors to respond, but also there would be a great increase in the number of impulses from individual receptors. The combined barrage of inhibitory impulses to the vasoconstrictor center would then lower systemic blood pressure. Likewise, when the carotid sinus pressure falls abnormally low, only the lower threshold receptors are stimulated and scarcely any inhibitory impulses reach the vasoconstrictor center. The result is a severe systemic vasoconstriction with a rise in systemic blood pressure.

I "Uncompensated" Dog —(a) *Effects of Clamping the Carotid Arteries* —This dog (Chart 3) had had a side-to-side carotid-jugular anastomosis performed two days before the experiment. With the fistula closed and the circulatory path normal, clamping of one carotid artery caused an appreciable rise in systemic pressure (II), which rose still higher when both carotids were closed (III). When the side-to-side fistula was opened (V), the increases upon clamping the carotid arteries proximal to the fistula were even more conspicuous (VI and VII), when repeated after denervation of both carotid sinuses, clamping either or both carotids caused no marked change in the greatly elevated pressure which follows this procedure (XIII and XIV).

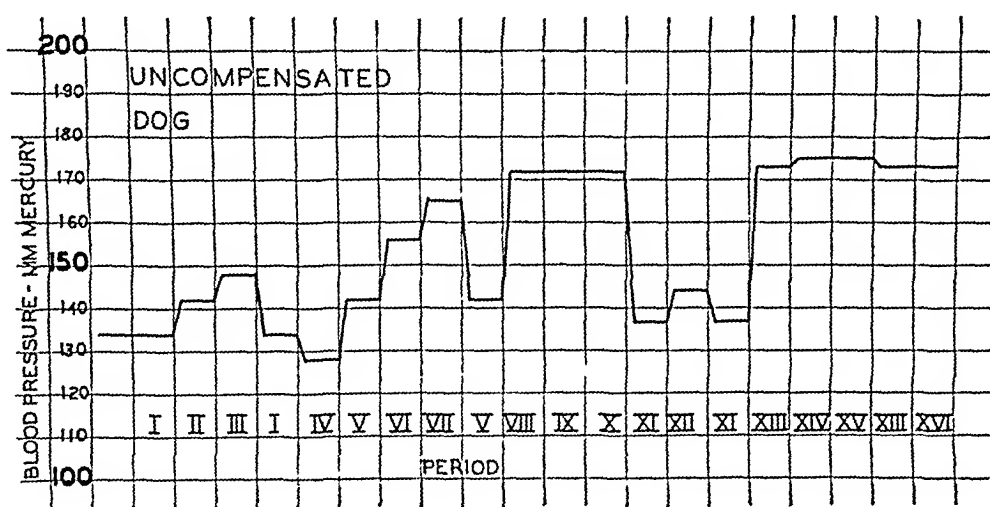


CHART 3 —Plotted blood pressure responses in an "uncompensated" dog 48 hours after formation of an 8 Mm carotid jugular fistula on the left side. Continuous line represents the pressure in the right femoral artery (mercury manometer). Period I: Fistula closed, normal circulation. II: Fistula closed, right carotid artery clamped. III: Fistula closed, both carotid arteries clamped. IV: Fistula opened end to end (i.e., with distal vessels clamped). V: Fistula opened side to side (i.e., with no vessels clamped). VI: Fistula opened with carotid proximal to it clamped. VII: Fistula side to side, both carotids clamped. VIII: Fistula side to side, opposite carotid sinus denervated. IX: Fistula side to side, opposite sinus denervated and carotid clamped. X: Same as Period VIII. XI: Fistula end to end, opposite carotid sinus denervated. XII: Fistula end to end, opposite sinus denervated, carotid clamped. XIII: Fistula side to side, both carotid sinuses denervated. XIV: Both sinuses denervated, carotid proximal to fistula clamped. XV: Both sinuses denervated, both carotids clamped. XVI: Both sinuses denervated, fistula end to end.

(b) *Effects of Opening the Fistula* —When the fistula was opened with distal carotid and jugular clamped (thus forming an end-to-end fistula), there followed a small but appreciable drop in systemic pressure (IV). When the distal vessels were unclamped, however (thus changing to a side-to-side fistula), the pressure rose to a level definitely above normal (V), the difference between these arrangements of the fistula being 14 Mm of mercury. After denervation of both carotid sinuses, changing from a side-to-side to an end-to-end fistula caused no change in blood pressure (XIII and XVI).

(c) *Effects of Denervation of Carotid Sinuses* —With the side-to-side fistula open, denervation of the opposite (left) carotid sinus caused a marked rise in systemic pressure (VIII). Closing and opening the carotid artery on the denervated side then failed to effect the pressure (IX and X). When

the fistula was changed to end-to-end, a fall occurred, but not to the level previous to denervation (IV and XI), and then closure of the carotid on the denervated side caused a definite additional rise in pressure (XII). Finally, after both carotid sinuses had been denervated, the elevated blood pressure was not affected appreciably by this type of fistula or the patency of the carotids (XIII and XVI).

II "Compensated" Dog—This dog (Chart 4) had had an end-to-end

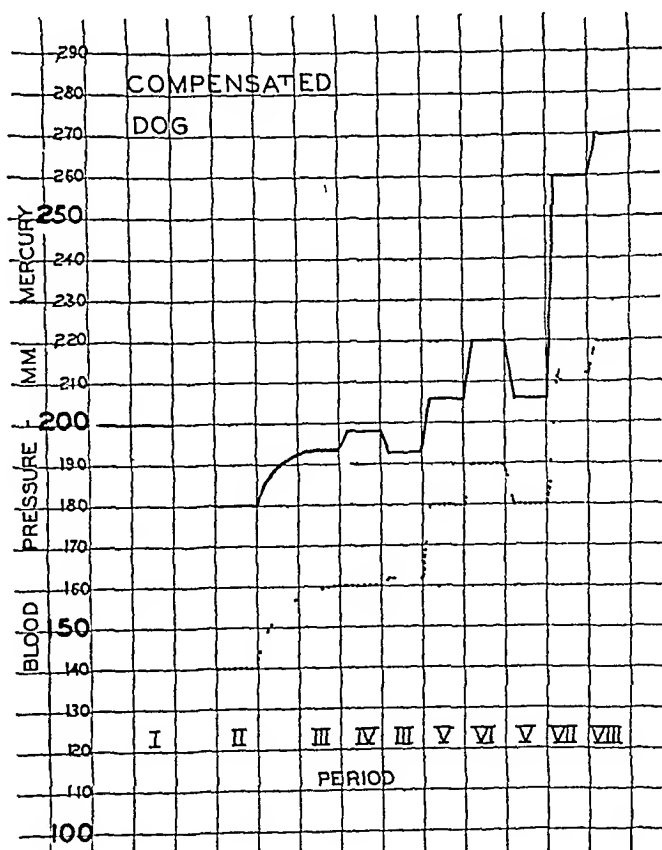


CHART 4.—Plotted blood pressure responses in a "compensated" dog (Dog 4) three months after formation of an 8 Mm end-to-end carotid jugular fistula, which had shrunk to 3 Mm. Continuous line represents the pressure in right axillary artery (Hürthle manometer). Dotted line represents the pressure in left carotid artery, the side of the fistula, proximal to the carotid sinus not communicating with the fistula. Period I Before beginning experiment. II After 24 hours' closure of fistula (20 Mm fall). III After reopening the fistula (gradual rise during 15 minutes). IV After closing fistula again (immediate small rise). V After denervation of right carotid sinus, with fistula open. VI Right sinus denervated, fistula closed. VII After denervation of both carotid sinuses, with fistula open. VIII Both sinuses denervated, fistula closed.

carotid-jugular anastomosis performed three months before the experiment, and was considered to be well compensated, with increased cardiac output and enlarged heart. It has been referred to already as Dog 4.

(a) *Effects of Opening the Fistula*—Twenty-four hours before the experiment the fistula was clamped during this period the mean systolic pressure fell 20 Mm (I and II). When the fistula was then reopened (III), there followed a rise toward the previous level, in contrast to the fall which

occurred in the uncompensated animal (Chart 3, I and IV) Closure of the fistula caused an immediate further rise (IV)

(b) *Effects of Denervation of Carotid Sinuses*—Denervation of the carotid sinus on the side of the fistula caused a considerable rise in pressure (III and V), and after both sinuses had been denervated a tremendous rise ensued (V and VII) After each of these procedures, closure of the fistula caused further increases in pressure, as it had before denervation (VI and VIII)

COMMENT—All observers agree that opening recently formed arteriovenous fistulae, irrespective of whether they are side-to-side or end-to-end, when between vessels other than the carotid and jugular, causes regularly a marked fall in systemic blood pressure The differences observed in carotid-jugular fistulae must then be explained, and can be attributed to effects on the carotid sinuses in the following way

To form an end-to-end fistula, the carotid artery proximal to the sinus on that side must be closed The pressure in that sinus, now maintained only through the circle of Willis, falls, and a vasoconstriction follows, which partially offsets the drop in systemic pressure due to the fistula, so that the resultant fall is slight (Chart 3, IV) A side-to-side fistula, on the other hand, due to the arterial communication through the circle of Willis, places the sinus, in effect, in circuit with the low resistance, low pressure fistula circuit (Fig 5) The carotid sinus pressure, therefore, falls even lower than when the artery is closed, with a resultant reflex vasoconstriction sufficient to more than offset the effect of the fistula, and cause a definite rise above normal (Chart 3, V) When, now, the carotid proximal to the fistula is clamped, arteriovenous communication exists only through the circle of Willis, thus not only lessening the effect of the fistula itself, but also places both carotid sinuses in the low pressure fistula circuit, resulting in a further rise in systemic pressure (Chart 3, VI)

Denervation of the sinus opposite to the fistula when this is open side-to-side (Chart 3, VIII) removes practically all sinus inhibition to vasoconstriction, sending the pressure almost as high as that which follows denervation of both sinuses (Chart 3, XIII), because the low pressure in the intact sinus, due to its communication with the fistula, fails to excite inhibitory impulses When, however, the fistula is changed to end-to-end (Chart 3, XI), and its communication with the intact sinus thus is blocked, the systemic pressure can affect the intact sinus through the circle of Willis, and stimulate inhibitory impulses which lessen vasoconstriction and result in a marked fall in pressure No such fall follows after both sinuses have been denervated (Chart 3, XVI)

These immediate compensatory blood pressure changes are vicious in that by diminishing the fall (in end-to-end fistulae) or causing an actual rise (in side-to-side) of systemic pressure, they force a greater proportion of the circulating blood through the fistula than would pass through a fistula of the same size elsewhere Exaggerated compensatory phenomena then ensue

The second animal (Chart 4) shows the result of this compensation. At the outset the formation of an end-to-end fistula, by lowering the pressure in the sinus on that side, set up a vasoconstriction which forced a large proportion of the circulating blood through the fistula. In response to the increased venous return the heart dilated, its contractile power increased and with this, its output. Progressive increase in blood volume, which is known to occur (Holman<sup>11</sup>) together with the increased cardiac output, raised the sinus pressure and eased off the vasoconstriction. Thus, the peripheral resistance was decreased, but the total capacity of the circulatory system was increased, necessitating a further compensatory increase in blood volume, until compensatory balance was reached between the peripheral resistance and that in the fistula circuit. Such balance was possible only with markedly elevated systolic pressure, great stimulation of the carotid sinuses, and consequent generalized vasodilatation. The hypertension and capillary pulsation which were so striking in the compensated dogs can be explained under this interpretation.

During the 24-hour period in which the fistula was closed, there was an immediate fall in cardiac output, and a beginning decrease in blood volume sufficient to result in a fall of 20 Mm of mercury in mean systolic pressure (I and II). When the fistula was then reopened the blood volume was still sufficiently high and the hypertrophied heart was able to regain a high output with sufficient speed, so that within 15 minutes two-thirds of the fall had been regained (III). That it was not entirely regained is presumably because some loss in blood volume had occurred which could not be regained in so short a time. The immediate result of closing the fistula was to throw that portion of the circulating blood which passed through it into the general circulation, and so the pressure was increased still further (IV). In these pressure rises (in contrast to those in the uncompensated animal) vasoconstriction plays no part, since even at the start the pressure is sufficiently high to produce reflex vasodilatation. How large a factor this is, is shown by the results of sinus denervation. The sinus on the side of the fistula, being connected with the circulation only through the circle of Willis, is not subjected to the full systemic pressure. Removal of inhibitory stimuli from it, therefore, though producing a marked vasoconstrictor rise (V), cannot compare to the enormous increase of nearly 70 Mm of mercury which follows complete denervation and consequent resumption of previously inhibited vasoconstrictor tone (VII).

**SUMMARY**—After a brief review of the literature, the results of an experimental study of carotid-jugular fistulae in dogs are presented as follows.

#### Group I—*Changes in the Heart and Proximal Arteries*

Following both end-to-end and side-to-side fistulae, of variable size and duration, cardiac enlargement occurred regularly, as shown roentgenologically. Evidence is presented that this enlargement was due to both hypertrophy and dilatation. Dilatation of the carotid arteries proximal to the



fistulae was observed, and dilatation of the ascending aorta has been demonstrated

#### Group II — *Changes in Cardiac Output*

Determinations made according to the Fick formula show increases of over 100 per cent to have occurred following the production of both types of fistulae. Changing side-to-side to end-to-end fistulae resulted in no essential change in output. Following spontaneous closure, or operative excision of the fistulae, return to a normal output is shown to have occurred.

#### Group III — *Changes in Arterial Blood Pressure*

A high pulse wave, with low dirotic and postdirotic waves, is shown, by photomanometric tracings, to be characteristic in animals with these fistulae, and the failure of the mercury manometer to register true blood pressure values under these circumstances is demonstrated. Blood pressure readings taken by a direct method (which is described) before and after formation of the fistulae are presented, which show a hypertension to have resulted regularly upon compensation to the fistula. The presence of capillary pulsation in dogs with compensated fistulae is noted.

#### Group IV — *Some Observations on the Rôle of the Carotid Sinus*

The marked changes in systemic blood pressure which followed manipulative alterations of the component blood vessels of carotid-jugular fistulae are contrasted in a "compensated" and an "uncompensated" animal, and are shown to have been abolished by denervation of the carotid sinuses. A hypothetical explanation of the rôle of the carotid sinuses in these changes and in the development of hypertension and capillary pulsation in the course of compensation to a carotid-jugular fistula is presented.

### CONCLUSIONS

(1) The phenomena which followed anastomosis of carotid artery to jugular vein in dogs resembled those reported by previous workers following both experimental and clinical arteriovenous communications between other vessels in the following respects: there was dilatation of the arteries between the fistula and the heart, the heart was both dilated and hypertrophied, and the cardiac output was greatly increased.

(2) These phenomena differed from those previously reported in the greater degree of the changes in proportion to the size of the fistula, and in the fact that a hypertension ensued.

(3) These differences can be explained by the more direct effects on the carotid sinuses of carotid-jugular fistulae than of fistulae between other arteries and veins.

(4) In view of these effects, the production of a carotid-jugular fistula as a therapeutic procedure seems ill-advised in any case, in degenerative diseases of the aorta it is contra-indicated, and in cases with cardiac damage it is dangerous.

## BIBLIOGRAPHY

- <sup>1</sup> Carrel, Alexis The Surgery of Blood Vessels Bull Johns Hopkins Hosp , 18, 18, 1907
- <sup>2</sup> Halsted, W S Congenital Arteriovenous and Lymphatico-venous Fistulae Unique Clinical and Experimental Observations Tr Am Surg A , 37, 262, 1919
- <sup>3</sup> Halsted, W S, and Reid, M An Experimental Study of Circumscribed Dilatation of an Artery Immediately Distal to a Partially Occluding Band, *etc* J Exper Med , 24, 271, 287, 1916
- <sup>4</sup> Reid, Mont R The Effect of Arterio-venous Fistula upon the Heart and Blood Vessels Bull Johns Hopkins Hosp , 31, 43, 1920
- <sup>5</sup> Lewis, T Studies of Capillary Pulsation, with Special Reference to Vasodilatation in Aortic Regurgitation, *etc* Heart, 11, 151, 1924
- <sup>6</sup> Lewis, T, and Drury, A N Observations Relating to Arteriovenous Aneurisms I Circulatory Manifestations in Clinical Cases Heart, 11, 301, 1923
- <sup>7</sup> Lewis, T, and Drury, A N II The Immediate Effects of an Arteriovenous Anastomosis on the Dog's Circulation Heart, 10, 365, 1923
- <sup>8</sup> Holman, Emil The Physiology of an Arteriovenous Fistula Arch Surg , 7, 64, 1923
- <sup>9</sup> Holman, Emil Arteriovenous Aneurism Clinical Evidence Correlating Size of Fistula with Changes in the Heart and Proximal Vessels ANNALS OF SURGERY, 80, 801, 1924
- <sup>10</sup> Holman, Emil Experimental Studies in Arteriovenous Fistulas I Blood Volume Variations Arch Surg , 9, 822, 1924
- <sup>11</sup> Holman, Emil, and Kolls, A O Experimental Studies in Arteriovenous Fistulae II Pulse and Blood Pressure Variations Arch Surg , 9, 837, 1924
- <sup>12</sup> Holman, Emil Experimental Studies in Arteriovenous Fistulae III Cardiac Dilatation and Blood Vessel Changes Arch Surg , 9, 856, 1924
- <sup>13</sup> Harrison, T R, Dock, W, and Holman, E Experimental Studies in Arteriovenous Fistulae Cardiac Output Heart, 11, 338, 1924
- <sup>14</sup> Hoover, C F, and Beams, A J The Diagnosis and Pathological Physiology of Arteriovenous Aneurism Arch Int Med , 33, 1, 1924
- <sup>15</sup> Reid, Mont R Abnormal Arteriovenous Communications, Acquired or Congenital I Report of a Series of Cases Arch Surg , 10, 601, 1925
- <sup>16</sup> Reid, Mont R Abnormal Arteriovenous Communications, Acquired or Congenital II The Origin and Nature of Arteriovenous Aneurisms, Cirroid Aneurisms and Simple Angiomas Arch Surg , 10, 996, 1925
- <sup>17</sup> Reid, Mont R Abnormal Arteriovenous Communications, Acquired or Congenital III Effects of Arteriovenous Communications on the Heart, Blood Vessels and Other Structures Arch Surg , 11, 25, 1925
- <sup>18</sup> Babcock, Wayne A New Treatment for Thoracic Aneurism Ann Clin Med , 4, 933, 1926
- <sup>19</sup> Churchill, E D, and Gibbon, J H Changes in Circulation Induced by Experimentally Produced Arteriovenous Fistulae Arch Surg , 21, 1188, 1930
- <sup>20</sup> Winslow, N, and Walker, W W Carotid-Jugular Anastomosis, Its Effect upon the Systemic Blood Pressure of the Dog ANNALS OF SURGERY, 100, 544, 1934
- <sup>21</sup> Bronk D H, and Stella, G Afferent Impulses from Single End Organs in the Carotid Sinus Proc Soc Exp Biol & Med , 29, 443, 1931-1932
- <sup>22</sup> Bronk D W and Stella G The Response to Steady Pressures of Single End Organs in the Isolated Carotid Sinus Am J Physiol , 110, 708, 1932
- <sup>23</sup> Schmidt, Carl F Carotid Sinus Reflexes to the Respiratory Center Am J Physiol , 102, 94 1934
- <sup>24</sup> Baker, A Provincial Med & Surg Jour , 14, 158, 1850 (Quoted by Reid, Nelson's Loose-Leaf Surgery )

# THE TREATMENT OF TETANUS WITH ANTITOXIN\*

AN ANALYSIS OF THE OUTCOME IN SIX-HUNDRED FORTY-TWO CASES

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UNEQUIVOCAL evidence for the therapeutic efficacy of antitoxin after the onset of symptoms of tetanus has been obtained only in animal experiments,<sup>5</sup> and differences between the experimental disease in laboratory animals and the clinical disease in man are sufficient to invalidate any argument by analogy. Most clinicians feel that the results of serum treatment of tetanus have been very disappointing, and data from the World War experience<sup>2,3</sup> seem to indicate that tetanus antitoxin, invaluable as a prophylactic, is relatively useless as a therapeutic measure. Nevertheless, the continued use of antitoxin in cases of tetanus indicates that the question is not settled, and it appears that further data are desirable.

A series of 642 cases was collected from the records of a group of hospitals.<sup>1</sup> The authors bear the sole responsibility for the presentation and interpretation of the figures, nevertheless, in the truest sense, the work represents a joint contribution of these hospitals, and we wish to acknowledge the great courtesy which we received from their administrative and professional staffs. Particular thanks are due to the record room workers.

Seventy-two cases from preantitoxin days form a control group. The remaining cases have been grouped according to the amount of antitoxin given within 12 hours of admission to a hospital,<sup>†</sup> and according to the method of administration. Since, in experimental tetanus, serum is apparently most effective if given intrathecally,<sup>7</sup> special attention has been given to the cases of patients treated in this manner. Such cases have been classified by the amount of antitoxin given by this route, only within 12 hours of admission. The groups and their respective mortalities are given in Table I.

The mortality for the untreated group approximates that of the whole

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\* Based upon a thesis submitted to the Faculty of the Yale University School of Medicine in candidacy for the degree of Doctor of Medicine, June, 1933.

† In most instances the dose cited was given within six hours of admission. In the few cases which developed in a hospital, the figures are for treatment given within 12 hours of the first symptoms. Submitted for publication April 17, 1936.

TABLE I  
MORTALITY IN UNTREATED CASES, AND IN GROUPS  
CLASSIFIED ACCORDING TO TREATMENT

Groups	Total Antitoxin within 12 hrs	Intrathecal Antitoxin within 12 hrs	Cases	Deaths	Mortality Per Cent
A	None	None	72	47	65.3
B	Less than 10,000 U	None	116	68	58.6
C	10,000 U or more	None	112	74	66.1
D	Not specified	Less than 2,000 U	74	47	63.5
E	Not specified	2,000-9,000 U	107	70	65.4
F	Not specified	10,000 U or more	161	99	61.5
Totals			642	405	63.0

series, and there are no significant differences among the several groups. Nearly all the patients who received intrathecal antitoxin received large intravenous and intramuscular doses in addition. Of the patients not treated intrathecally, many of those (Group C) received very large amounts of antitoxin within the stated time. All but six of these patients received at least 20,000 units within 12 hours after hospitalization. From these data it is evident that small or large doses of antitoxin have little effect on the mortality.

The figures generally cited as evidence for the therapeutic value of diphtheria antitoxin are those correlating early treatment and low mortality. However, in the study of these tetanus cases it soon became evident that the mortality was highest in patients admitted to the hospital within 24 hours of the first symptoms, in both the untreated and treated groups. In Table II the entire series is analyzed according to two prognostic criteria, the incubation period, and the time between the onset of symptoms and hospitalization. The correlation between the two is interesting.

It will be seen that in the cases of patients admitted on the first day the incubation period is usually short. Both the incubation period and the duration of symptoms to admission must be considered in evaluation of the prognosis, but the latter seems actually the more important. This observation does not mean that early treatment was harmful. It merely shows that the rapidity with which symptoms progress is an important factor in the prognosis. Patients whose symptoms compel them to seek hospitalization within 24 hours of the onset of the disease are patients with severe tetanus. However, these figures confirm the belief that the effect of antitoxin treatment cannot be great.

Since serum treatment, if effective at all, should be chiefly so on the first day of the disease, it seemed desirable to select from the treated and untreated groups cases of patients admitted within this interval whose incubation periods were comparable. The figures are given in Table III.

Here again it is clear that treatment is not associated with a marked diminution of mortality. There is a slight difference in favor of the patients

TABLE II

AN ANALYSIS OF THE OUTCOME IN 642 CASES OF TETANUS, WITH REFERENCE TO INCUBATION PERIOD, AND THE DURATION OF SYMPTOMS OF TETANUS UP TO THE TIME OF HOSPITALIZATION

TREATMENT OF TETANUS

Incubation (days)	1		2		3		4		5		6 & +		Uncertain*		Total	
	D	R	D	R	D	R	D	R	D	R	D	R	D	R	D	R
0-7	98	10	34	8	8	1	2	8	0	0	1	6	17	3	158	36
8-14	45	15	33	17	12	15	10	11	0	1	2	15	25	5	127	79
15-21	7	6	7	6	5	5	2	6	1	3	1	15	7	4	30	45
More than 21	3	0	3	4	1	4	3	1	0	1	0	1	2	1	12	12
?	27	5	9	4	14	11	4	12	3	7	7	20	12	6	78	65
Total	180	36	86	39	40	36	21	38	4	12	11	57	63	19	405	237

D = deaths    R = recoveries

\* This column includes cases in which the duration of symptoms was not stated in the history, and the few cases which developed in a hospital

TABLE III  
CASES OF PATIENTS ADMITTED ON FIRST DAY OF  
SYMPTOMS OF TETANUS

Group	Incubation 0-7 Days			Incubation 8-14 Days		
	Cases	Deaths	Mortality	Cases	Deaths	Mortality
A	11	11	100 0%	1	1	100 0%
C	15	14	93 3%	15	13	86 7%
A-D incl	57	54	94 7%	36	30	83 3%
E and F	51	44	86 3%	24	15	62 5%

receiving over 2,000 units intrathecally. This difference is barely twice the calculated standard deviation,<sup>6, 7</sup> such a difference is classed as "probably significant" by some statisticians. However, unqualified "significance" is attributed only to differences of a magnitude at least three times that of the standard deviation. The present data might be interpreted as a corroboration of the experimental data in favor of intrathecal treatment, but their evidential value is slight.

TABLE IV  
MORTALITY IN PATIENTS ADMITTED ON FIRST DAY OF SYMPTOMS, WHOSE  
INCUBATION PERIODS WERE NOT LONGER THAN 14 DAYS

<i>Comparison of Groups A-D with Groups E-F</i>				
Groups	Cases	Deaths	Mortality	
A-D	93	84	90 3%	
E-F	75	59	78 7%	
Difference			11 6%	
Calculated Standard Deviation			5 5%	

The figures given here confirm those of previous workers,<sup>2, 3</sup> and indicate that relatively little has been accomplished in the specific treatment of tetanus. Further work may confirm or deny the suggestion as to the desirability of intrathecal treatment. It is hoped that the data in Table II may be of value as a control for further therapeutic experiments. At present it would seem that adequate sedation was the most hopeful line of attack.

#### REFERENCES

- <sup>1</sup> Data were collected from the following hospitals: in Boston, Children's, Massachusetts General, Boston City; in Hartford, Conn., Hartford Hospital; in New Haven, Conn., New Haven Hospital; in New York, Presbyterian, Babies', Roosevelt, Mt. Sinai, Bellevue; in Philadelphia, University of Pennsylvania, Children's, Episcopal, Jefferson, Presbyterian; in Baltimore, Johns Hopkins; University of Maryland; in St. Louis, Barnes and St. Louis Children's.
- <sup>2</sup> Bruce, David. Tetanus. Jour Hyg, 19, 1920.
- <sup>3</sup> Golla, F. An Analysis of Recent Tetanus Statistics. Lancet, 2, 966, 1917.
- <sup>4</sup> Huntington, R. W., Jr. Treatment of Tetanus. Yale Jour Biol and Med, January, 1931.
- <sup>5</sup> Sherrington, C. S. Observations with Antitetanus Serum in the Monkey. Lancet, 2, 96, 1917.
- <sup>6</sup> Topley, W. W. C. and Wilson, G. S. Principles of Bacteriology and Immunity. New York: Wm. Wood and Co., 1929.
- <sup>7</sup> Yule, G. Udny. An Introduction to the Theory of Statistics, 9th ed. Charles Griffin, Ltd., London, 1929.

# ACUTE SUPPURATIVE TENOSYNOVITIS OF THE FLEXOR TENDON SHEATHS OF THE HAND

A REVIEW OF ONE HUNDRED AND TWENTY-FIVE CASES

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INFECTIONS of the flexor tendon sheaths of the hand present a problem still far from solution. They are of importance because of their frequency, their notoriously poor results, and the likelihood of permanent disability. Little progress has been made in their treatment in recent years. Surprisingly few large series of cases have been reported in the literature with enough follow up reports to give a true picture of the end-results. The most comprehensive reviews in the past have been those of Forssell<sup>1</sup> (1903), Keppler<sup>2</sup> (1912), Cleveland<sup>3</sup> (1924), Garlock<sup>4</sup> (1924), Schiessl<sup>5</sup> (1925), Brofeld<sup>6</sup> (1929), and Deike<sup>7</sup> (1933). In most of these, however, the follow up results were scanty. This review is an attempt to supply that defect. The series includes 125 cases admitted to the wards of this hospital over a 17 year period from 1916 to 1933. The average period of observation after operation was 16 months. A few cases were omitted because of insufficient data or because of an inadequate follow up report. During this period there were seven cases of gonococcus tenosynovitis which were not included in this analysis and which will be discussed only briefly.

*Origin of Infection*—Infection may reach the sheath by any one of four routes. It may be introduced by primary direct inoculation as by a puncture wound, by secondary extension from a neighboring infection, by the blood stream, or by lymphatic spread from a more distant focus. None of the cases was infected by the hematogenous route except the seven gonococcus infections which will be discussed separately. Lymphatic involvement of a sheath from a distance must be rare. In spite of a careful search no instance of it was found in this series. Kanavel<sup>8</sup> believed it occurred occasionally following a lymphangitis on the volar surface of the finger. Forssell<sup>1</sup> reported three cases of ulna bursitis following a thumb infection, without suppuration of the radial bursa, which he believed were lymphatic in origin. These cases, however, are not very convincing.

As the hematogenous and lymphatic sources of infection can be eliminated here, the cases fall into two main groups, primary and secondary. The primary group represents those cases in which the infection has been implanted directly into the sheath at the time of injury. The secondary group includes those cases in which the sheath was involved by extension from a neighboring infection, usually an overlying abscess. These two groups differ considerably in their characteristics as will be shown by later comparisons. The

differentiation between them in this review was not always easy but could usually be made fairly accurately from the type and site of injury, the symptomatology, and the findings at operation. There were 67 primary cases, or 54 per cent, and 58 secondary cases, or 46 per cent.

*Trauma*—A history of preceding injury was obtained in 92 per cent of the cases. As shown in Table I a puncture wound was by far the most frequent cause, occurring in 64 cases or 51 per cent. The outstanding feature was the insignificant character of the wound in most cases. Not infrequently the injury was so slight that the patient had difficulty in remembering it. Four of the infections were due to human bites and will be discussed more at length later.

TABLE I  
TYPES OF INJURY CAUSING TENOSYNOVITIS

	Cases	Per Cent
Puncture wounds	64	51
Lacerations and incised wounds	39	32
Unknown	10	8
Contusions	4	3
Burns	4	3
Human bites	4	3
Totals	125	100

*Wound of Entrance*—The frequent origin of tenosynovitis from injury at the flexor creases of the fingers has long been recognized. This series adds further emphasis to this site of origin. In nearly half the cases, 59 or 47 per cent, the wound of entrance was in, or close to, the flexor finger crease. The distal finger crease was the one most frequently involved and was by far the commonest site of entrance of infection anywhere on the fingers or hand. It was involved in 41 instances or 33 per cent in this series. The proximal interphalangeal crease was the site of entry in 13 cases or 10 per cent. At the distal and proximal interphalangeal creases the tendon sheaths are more superficial and are free of the thick annular ligaments which at other points bind them to the phalanges. The absence of this fibrous layer beneath the crease makes free motion possible yet at the same time leaves the sheath more vulnerable to injury and infection. The more frequent involvement of the distal crease may be due to its greater exposure to injury and to the fact that of the three creases it lies closest to the tendon sheath. Only a very slight injury or puncture wound in this region may infect it. The metacarpophalangeal crease was implicated in only 4 per cent of the cases. The tendon sheath beneath this crease is quite superficial but is protected by the phalangeal annular ligament which is absent at the other creases. Cases of tenosynovitis due to injury at the creases were mostly primary infections (68 per cent) from direct inoculation.

Tenosynovitis arising from injury or infection elsewhere than from a finger crease occurred in 63 cases or 51 per cent. The most common site



# TENOSYNOVITIS OF HAND

TABLE II

## SITE OF WOUND OF ENTRANCE

Site		Cases	Per Cent
At finger crease	Distal crease	41	33
	Middle crease	13	10
	Proximal crease	5	4
	Totals	59	47
Not at finger crease	Distal closed space	23	19
	Middle closed space	13	10
	Proximal closed space	16	13
	Palm	7	6
	Dorsum of hand or finger	4	3
	Totals	63	51
Unknown		3	2
Totals		125	100

was the distal closed space, occurring in 23 cases or 19 per cent of the series. Twenty-one of these 23 cases were of the secondary type. The proximal and middle closed spaces and the palm were less frequently at fault in the order named. The involvement of the tendon sheath secondarily from the distal closed space is of interest and illustrates the two routes of infection that have been emphasized by Auchincloss<sup>9</sup>. In 10 of the 21 cases in which the sheath was thus involved, the infection apparently invaded the end of the sheath directly from the adjacent soft tissues, in the remaining 11 cases, it reached the sheath by way of the shaft of the distal phalanx, the volar subtendinous space, and the distal phalangeal joint, usually with an osteomyelitis of both the distal and middle phalanges. The frequency of tenosynovitis secondary to infection of the distal closed space emphasizes the importance of early and adequate drainage of these infections.

*Site*—The right hand was involved in 67 per cent of the cases, or twice as often as the left. The difference is obviously due to the greater use of the right hand and the greater chance of injury. The incidence of tendon sheath infection in the different fingers is shown in Table III. The thumb, index, and middle fingers were most often affected, probably in direct proportion to their more general use. The index finger came first. Other

TABLE III

## DISTRIBUTION OF CASES OF TENOSYNOVITIS IN FINGERS

	Cases	Per Cent
Thumb	22	18
Second finger	44	35
Third finger	33	26
Fourth finger	17	14
Fifth finger	9	7
Totals	125	100

reported series of tenosynovitis show a similar incidence, but with the thumb or third finger in first place

*Age and Sex*—There were 68 males and 57 females. The average age was 37, the youngest being five and the oldest 71.

*Diagnosis*—Early recognition of tendon sheath infection is of paramount importance. Failure to recognize it at the outset and the consequent delay in operation are probably the main causes of the prevalent poor results. In 31 cases of this series, or 25 per cent, the diagnosis was not made at the first visit to the hospital. In the group with primary infection the diagnosis was missed in only 13 per cent of the cases, but in the group secondarily infected it was missed in 38 per cent and was often not made until after several days' delay (Table IV). The average delay in operation because of error in diag-

TABLE IV

ACCURACY OF DIAGNOSIS IN PRIMARY AND SECONDARY CASES AND IN WHOLE SERIES

	Primary		Secondary		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Correct diagnosis	58	87	36	62	94	75
Incorrect diagnosis	9	13	22	38	31	25

nosis in the primary group was one day, whereas in the secondary group it was over four days. The difference between the two groups is not surprising. In the primary group the classic signs of tendon sheath involvement are usually clear cut. The presence of tenderness localized definitely to the region of the sheath, the flexed position of the finger, and the exquisite pain on passive extension of the distal phalanx, are signs which leave little doubt as to the diagnosis. Of these, localized tenderness over the sheath is by far the most reliable. A wound of entry over the course of the sheath is usually present also. Usually these signs are easy to elicit, except in cases with a partially draining sheath in which they may be obscured because of lack of tension of the exudate in the sheath. Such cases are not an infrequent source of error in diagnosis. In the secondary group the diagnosis is more difficult. Here the presence of infection in the tissues outside the sheath confuses the picture. It is often difficult to decide whether or not the sheath has been invaded, especially in those cases in which only a localized portion of the sheath has been involved, as not infrequently happens. It should be strongly emphasized, however, that when the diagnosis of suppurative tenosynovitis is in doubt, it is usually better to operate than to delay. This point will be discussed subsequently in greater detail.

*Classification of Results*—The results in this series of 125 cases were based on an average follow up period of 16 months. In evaluating the end-results, anatomic, symptomatic, and economic factors were considered, but the chief emphasis was placed upon the functional result. The classification into four groups used by Cleveland<sup>3</sup> was adopted with slight modifications.

# TENOSYNOVITIS OF HAND

*Group I—Bad Results*—This group included deaths, amputations, and deformed, stiff, often painful fingers without motion at the interphalangeal joints and little at the metacarpophalangeal joint

*Group II—Fair Results*—Nearly complete motion at the metacarpophalangeal joint but no active motion at the interphalangeal joints

*Group III—Good Results*—Complete function at the metacarpophalangeal joint and slight active motion at the interphalangeal joints

*Group IV—Optimal Results*—An almost complete return of normal function in the finger There may be very slight limitation of extreme flexion or extension but the finger is practically as useful as before the infection

*Results*—The final results in the 125 cases of this series were discouraging Over one-third of all the cases fell into Group I Nearly two-thirds of the cases were in Groups II and III Only one-sixth regained approximately full function (Table V) These results were similar to those of

TABLE V

## A COMPARISON OF RESULTS BY GROUPS

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Totals
Present series	44	35	31	25	29	23	21	17	125
Present series (15 cases with tendon necrosis at operation omitted)	34	31	28	25	27	25	21	19	110

Cleveland,<sup>3</sup> whose 57 cases from this hospital were included in the present series As it seemed perhaps unfair to include very advanced cases, another summary was made omitting 15 cases which showed definite necrosis of the tendon at operation These results, however, were only slightly better Other reported series show varied figures Keppler,<sup>2</sup> Schiessl,<sup>5</sup> and Deike<sup>7</sup> classified their cases according to function into three groups—good, average, and poor An attempt was made to reclassify our results for comparison They proved to be very similar to those of Deike, but much poorer than those of the other two authors (Table VI) Perhaps the discrepancy can be partly explained by differences in follow up methods Schiessl did not

TABLE VI

## A COMPARISON OF RESULTS WITH THOSE IN OTHER SERIES

### *Reclassified into Three Groups*

	Poor		Average		Good		Totals
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	
Keppler (1912)	35	28	13	10	79	62	127
Schiessl (1925)	19	28	10	14	39	57	68
Deike (1933)	106	53	34	17	60	30	200
Present series (re-grouped)	63	50	27	22	35	28	125

state whether his cases were followed or not. Keppler reexamined about one-half of his cases but did not state the length of follow up. Deike followed only one-third of his series, largely by questionnaire. The cases reported here were followed for an average period of 16 months after operation by actual interview and examination in nearly every case.

*Tendon Necrosis*—Gross sloughing of the tendons in whole or in part was very frequent and was noted in 52 per cent of the cases. It was possibly even more frequent but was not recorded. Deike<sup>7</sup> noted it in about one-fourth of his 200 cases. Garlock<sup>4</sup> reported necrosis of the tendon or tendon sheath in 72 per cent of his 42 cases. A comparison between the incidence of tendon slough and the results showed a close correlation between the two. The one case in Group IV showing tendon necrosis was one in which a small portion of the flexor carpi radialis tendon sloughed, leaving no perceptible loss in function. Of the five cases in Group I without tendon slough, four had stiff contracted fingers and one died of sepsis (Table VII).

TABLE VII

## INCIDENCE OF TENDON NECROSIS IN THE RESULT GROUPS

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Tendon intact	5	11	14	45	21	72	20	95	60	48
Tendon sloughed	39	89	17	55	8	28	1	5	65	52

Necrosis of the tendon was slightly more frequent in secondary than in primary infections, occurring in 55 per cent of the former and 40 per cent of the latter. The infection in the soft tissues outside the tendon sheath, which is present in secondary cases, tends to prolong the infection within the sheath and compromise the tendon.

As later discussion will show, tendon necrosis occurred with about equal frequency in Staphylococcus and Streptococcus infections but much more frequently in mixed infections with two or more organisms.

*Bacteriology*—Culture reports were obtained in all but 13 cases. With but few exceptions these were taken at operation. Further cultures were rarely taken. It is probable that secondary contamination with other organisms frequently occurred later and may have influenced the course of the infection. The Streptococcus hemolyticus was the organism most frequently found, and was present in pure culture at operation in 45 cases (36 per cent), and the Staphylococcus in 39 cases (31 per cent). The remaining 28 cases included 13 cases of mixed Streptococcus hemolyticus and Staphylococcus, eight cases in which no growth was reported, five cases of mixed organisms, three of which contained *B. coli*, and two cases of nonhemolytic streptococcus in pure culture. Keppler's<sup>2</sup> series showed a very similar distribution of organisms. In most of the other reported series, however, few if any cultures were reported.

The results were definitely better in the Staphylococcus than in the Streptococcus cases. The mixed Streptococcus hemolyticus and Staphylococcus cases held an intermediate position and appeared to do slightly better than the Streptococcus cases in pure culture but were too few in number for fair comparison. The other instances of mixed infection did poorly. A number of these were very late cases. Those in which no growth was reported did unusually well. Some were very early cases and several may have been unrecognized cases of gonococcus tenosynovitis. The 13 cases in which no culture report was received did extremely poorly (Table VIII). Some were late, advanced cases in which the culture was neglected. The poorer prognosis in the Streptococcus cases is somewhat surprising. Keppler<sup>2</sup> and Cleveland<sup>3</sup> noted this also. This group, however, included most of the very severe spreading infections and most of the bad complications.

TABLE VIII  
A COMPARISON OF RESULTS ACCORDING TO BACTERIOLOGY

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Streptococcus hemolyticus	19	42	13	29	8	18	5	11	45	36
Non-hemolytic streptococcus	—	—	1	50	—	—	1	50	2	21
Staphylococcus	10	25	8	21	13	33	8	21	39	3
Streptococcus hemolyticus and Staphylococcus	5	38	2	16	5	38	1	8	13	10
Miscellaneous	3	60	2	40	—	—	—	—	5	4
No growth	—	—	1	12	2	25	5	63	8	7
No report	7	54	4	30	1	8	1	8	13	10
Totals	44	35	31	25	29	23	21	17	125	100

The incidence of tendon slough was about the same in both the Streptococcus hemolyticus and Staphylococcus groups. It was much higher in cases of mixed infection with two or more organisms (Table IX).

TABLE IX  
A COMPARISON OF THE INCIDENCE OF TENDON NECROSIS WITH BACTERIOLOGY

	Tendon Intact		Tendon Sloughed		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Streptococcus hemolyticus	25	56	20	44	45	36
Non-hemolytic Streptococcus	1	50	1	50	2	2
Staphylococcus	21	54	18	46	39	31
Streptococcus hemolyticus and Staphylococcus	5	38	8	62	13	10
Miscellaneous	—	—	5	100	5	4
No growth	7	88	1	12	8	7
No report	1	8	12	92	13	10
Totals	60	48	65	52	125	100

The Streptococcus was found more often in primary tenosynovitis than the Staphylococcus. Sixty-nine per cent of the Streptococcus cases were of this kind as compared to 44 per cent of the Staphylococcus cases. Similarly, the Staphylococcus was more frequently present in secondary tenosynovitis.

The exact importance of secondary contamination was not determined. To do this repeated cultures in each case would have been necessary. Its importance, however, is undoubtedly great. Since 1921, especial care was taken in the early dressings to prevent it. The hand and forearm were kept in sterile towels. Dressings were touched only with sterile gloves or instruments. If soaks were used every precaution was taken to keep them sterile as well.

*Primary and Secondary Tenosynovitis*—This analysis has already shown that secondary tenosynovitis is more difficult to diagnose and more prone to tendon necrosis than primary tenosynovitis. It is most frequently due to the Staphylococcus whereas primary infections are usually due to the Streptococcus. Further analysis will show that secondary tenosynovitis is more apt to cause a localized type of infection with only a partial involvement of the tendon sheath. Contrary to expectation, a comparison between results in primary and secondary tenosynovitis did not show great differences. Both Cleveland<sup>3</sup> and Iselin<sup>10</sup> have stressed the better prognosis in primary cases. In this series the high incidence of primary cases in Group I was due largely to severe Streptococcus infections which were mainly primary. These were offset, however, by a large number of secondary cases in Group I due to late diagnosis and operation, often with extensive infection adjacent to the sheath. The good showing of the secondary cases in Group III was due largely to the inclusion here of secondary cases with only limited sheath involvement and consequently only slight disability. The larger number of primary than secondary cases in Group IV suggests that the best results can be expected in primary cases treated early.

*Results in the Different Fingers*—A comparison of the results of tenosynovitis in the various fingers is of interest in showing that the best results occurred in the thumb and the poorest in the fifth finger. If the results in both Group III and IV are combined, the thumb ranks first in spite of the fact that the radial bursa was involved in every case but one and in spite of the frequent extension of the infection to the ulna bursa. When the infection was limited to the digital sheath and radial bursa, the results were unusually good with eight of the 13 cases falling into Group III. When the infection extended to the ulna bursa, however, the results were all very poor. Seven of the eight cases with this extension had to be placed in Group I. The remaining one had fair function, but only because the extension was limited to the ulna bursa above the wrist. Thus, notwithstanding the danger of ulna bursitis, the results in the thumb were better than in the other fingers. Deike<sup>7</sup> obtained his best results in the fourth finger. The thumb ranked low because of the very high incidence of ulna bursa extension in his cases. The better prognosis in the thumb is due to several factors. Since the thumb has

one less phalanx than the other fingers, a sloughed or adherent tendon causes less functional disability. There is loss of motion in the phalangeal joint only, as other muscles provide motion in the metacarpophalangeal joint. The thumb has also only one flexor tendon in its sheath instead of the two present in the other fingers, which often become adherent to each other after infection. The tendon to the thumb lies for most of its course at a deeper level than the other tendons and is less apt to become attached to the skin after incision. Moreover, involvement of the radial bursa in the palm and above the wrist does not usually cause much additional disability unless the tendon sloughs.

In the fifth finger, the results were poor. This finger has none of the advantages of the thumb. Moreover, it has an extensive sheath which includes the tendons of the three middle fingers and which if infected may cripple them as well. Deike also had his poorest results in this finger (Table X).

TABLE X

## END-RESULTS IN THE DIFFERENT FINGER SHEATHS

	Group I		Group II		Group III		Group IV			
	Bad		Fair		Good		Optimal			
	Results		Results		Results		Results		Totals	
		Per		Per		Per		Per		Per
	Cases	Cent	Cases	Cent	Cases	Cent	Cases	Cent	Cases	Cent
Thumb	8	36	3	14	9	41	2	9	22	18
Second finger	16	35	12	27	9	20	8	18	45	36
Third finger	11	45	7	21	5	15	10	30	33	27
Fourth finger	6	37.5	4	25	6	37.5	—	—	16	12
Fifth finger	4	44.5	4	44.5	—	—	1	11	9	7

*The Bursae*—The radial bursa was involved alone without associated infection of the ulna bursa in 13 cases. In six the whole bursa and digital sheath of the thumb were involved, and in seven cases the digital sheath and bursa in the palm were infected without extension above the wrist. In only one case was the digital sheath of the thumb involved alone without extension upward to the bursa. The bursa was never found infected without the digital sheath. Forssell did not find it to have occurred in his cases or in any of those in the literature. Anatomic studies help to explain this. According to Poirier,<sup>12</sup> the sheath communicates freely with the bursa in 95 per cent of cases. The organisms responsible for these infections were well distributed among the different groups with the *Streptococcus hemolyticus* the most frequent. As has been shown, the results were surprisingly good with most of the cases falling into Group III. The failure of the infection to extend to the bursa above the wrist in more than half the cases is of interest. I know of no anatomic explanation. It was probably due to the walling off of the sheath by exudate ahead of the infection.

The ulna bursa was involved alone without associated radial bursitis in eight cases. In three the infection included the fifth finger sheath and the

whole bursa, in three cases it affected the finger sheath and the bursa in the palm only, and in two cases it involved the bursa in the palm and above the wrist without the digital sheath. In two cases the fifth finger sheath was involved without any extension to the bursa. The frequent infection of the digital sheath or bursa without the other may be partly explained on anatomic grounds. Poirier found full communication in only about one-half of his dissections. The others showed either narrowing or complete occlusion. Half of the ulna bursa cases in this series were caused by the *Streptococcus hemolyticus* in pure culture. The results were nearly all very poor.

There were ten instances of combined infection of both radial and ulna bursae. These infections are notorious for their severity, rapid spread, and crippling results. Most of the major complications occurred in this group. In nine of these cases the infection spread from the radial to the ulna bursa and in only one did it spread from the ulna to the radial bursa. The frequent extension of the infection from one bursa to the other may be due to actual communication or to their proximity. Poirier found free connection to occur in about one-half of his dissections, usually by way of one or two small intervening bursae. In our series 41 per cent of the radial bursitis cases spread to the ulna bursa and only one case of ulna bursitis spread in the reverse direction. Other authors report a higher incidence. Forssell,<sup>1</sup> Brofeld,<sup>6</sup> and Deike<sup>7</sup> had 85, 76, and 43 per cent respectively of radial to ulna bursa extensions, and 21, 0, and 35 per cent of ulna to radial bursa extensions. Brofeld encountered no instance of ulna-radial bursa spread. The more frequent extensions in these series may be due to a larger number of late neglected cases. The preponderance of spread from the radial to the ulna bursa as compared to that in the reverse direction is noteworthy and has been reported by other authors. No satisfactory explanation, however, has been offered. The involvement of the bursae and finger sheaths was complete in all but two cases. The *Streptococcus hemolyticus* was present in every case but one. In seven it was recovered in pure culture and in two cases it was combined with the *Staphylococcus*. This is the organism one would expect in such virulent and wide spread infections. The results were extremely bad. Every case but one fell into Group I.

TABLE XI

## RESULTS IN RADIAL AND ULNA BURSAE

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		Totals
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases
Radial bursa	1	8	2	15	8	62	2	15	13
Ulna bursa	3	38	4	50	—	—	1	12	8
Radial and ulna combined	9	90	—	—	1	10	—	—	10



*Duration of Tenosynovitis Before Operation and Results*—The average duration of tenosynovitis before operation was 6.2 days. This long period of delay was probably the chief cause of the poor end-results. The average delay before operation in Group IV was 3.4 days as compared to 9.3 days in Group I. This delay was due in part to errors in diagnosis in our own Out-Patient Clinic, but chiefly to delay before coming to the Clinic. A comparison of the cases without tendon necrosis with those with necrosis also showed the importance of the time factor. The average duration of symptoms in the former was 3.6 days as compared to 8.3 days in the latter. The time factor is not, however, the only one; some cases operated upon within 24 hours of the beginning of the infection did badly and others incised after days of delay had nearly perfect function. But these were the exceptions.

TABLE XII

AVERAGE DURATION OF TENOSYNOVITIS BEFORE OPERATION IN THE RESULT GROUPS

	Group I Bad Results	Group II Fair Results	Group III Good Results	Group IV Optimal Results	General Average
Average days duration before operation	9.3	5.0	4.6	3.4	6.2

*Age and Results*—The effect of age on the results and on the incidence of tendon necrosis was also studied. Cases with poor results tended definitely to fall into an older age group than those with good results. The average age of the cases in Group IV was 30 years as compared to 42 years in Group I, an average difference of 12 years. The frequency of tendon slough also increased with age. Thus the average age of patients without tendon necrosis was 32 years as compared to 42 years among those with necrosis (Table XIII). Patients who developed complications were also slightly older on the average. Those with severe infections such as combined radial and ulna bursa involvement had an average age of 44 years as compared to the general average of 37. Deike,<sup>7</sup> Forssell,<sup>1</sup> zur Verth,<sup>11</sup> and Kanavel<sup>8</sup> likewise emphasized the poorer prognosis in older patients and the greater frequency of sepsis and other complications among them. Deike even claimed that his favorable results only occurred in patients under 30 years of age. Moissejeff<sup>12</sup> attributed this phenomenon to increasing atherosclerotic changes in the tendon in later life.

TABLE XIII

RELATION OF AGE TO TENDON NECROSIS AND END-RESULTS

	Tendon Intact	Tendon Sloughed	Group I Bad Results	Group II Fair Results	Group III Good Results	Group IV Optimal Results
Average age (years)	32	42	42	37	31	30

*Recent Versus Older Results*—A comparison of results of cases operated upon in the decade from 1916 to 1925, as compared to a nearly equal number in the eight years from 1926 to 1933 inclusive, was disappointing (Table

XIV) It showed only slight improvement in the more recent group in spite of a campaign for earlier diagnosis, earlier removal of drains, and a more rigid aseptic dressing technic, designed to prevent secondary contamination. The results are still very poor and allow of much greater improvement.

TABLE XIV

A COMPARISON OF RESULTS IN THE 10 YEAR PERIOD (1916-1925) AND 8 YEAR PERIOD (1926-1933)

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
1916-1925	24	40	15	25	12	20	9	15	60	48
1926-1933	20	31	16	25	17	26	12	18	65	52

*Soaks Versus Moist Dressings*—An attempt was made to compare results according to the type of treatment used after operation. This was found to be difficult because of the wide variety of procedures and the frequent shift from one treatment to another. The chief difference was found to be in the use of sterile hand soaks of saline or boric solution as compared to the use of sterile gauze compresses which were moistened frequently with these solutions without disturbing the dressing. The soaks were given for about 30 minutes every three or four hours. Large deep basins were used in which the whole hand and forearm could be immersed to above the elbow. A third group included those cases in which neither of the above procedures had been carried out consistently and in which Dakin's solution was also frequently used. These were usually late neglected cases.

The results seemed to show the wet dressing procedure to be preferable to the soaks (Table XV). Using the presence or absence of tendon slough as a criterion, the advantage seemed to rest also with the wet dressings. The arguments advanced for the soaks are that they allow earlier finger motion and better cleansing of the wounds. Against them is the difficulty of preventing secondary contamination and the impossibility of maintaining elevation of the hand while in the soak, with consequent congestion of the tissues. It should be emphasized again, however, that, because of the many variable factors and the short duration of the procedure in many cases, the comparison is open to question.

TABLE XV

COMPARISON OF RESULTS BETWEEN CASES TREATED WITH WET DRESSINGS AND HAND SOAKS

	Group I Bad Results		Group II Fair Results		Group III Good Results		Group IV Optimal Results		Totals	
	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent	Cases	Per Cent
Wet dressings	9	26	7	21	8	24	10	29	34	27
Hand soaks	26	34	22	29	18	24	10	13	76	61
Miscellaneous	8	53	4	27	2	13	1	7	15	12

*Complications*—There was only one death in this series, a percentage of 0.8. This was a case of *Streptococcus hemolyticus* infection involving the radial bursa and spreading to the forearm. The patient developed a positive blood culture on the fifth day after operation and died the next day, following a severe hemorrhage from the radial artery. Other authors have found the mortality higher. Klapp,<sup>14</sup> Keppler,<sup>2</sup> and zur Verth<sup>11</sup> had an incidence of between 3 and 5 per cent. Deike<sup>7</sup> had 16 deaths in 200 cases, or a mortality of 8 per cent. These were mostly in old people with sepsis.

Amputation of an arm or finger was performed in 11 cases or 8 per cent. Eight were finger amputations and were thought advisable because of extensive tendon slough and osteomyelitis in six cases and for severe contractures in two cases. One amputation through the midforearm and two through the upper arm were performed because of severe infection. One of the latter was accompanied by recurrent hemorrhage from the radial artery. A stiff finger, if ankylosed in the optimum position of slight flexion, is usually useful, although the two distal phalangeal joints are frequently stiff, the metacarpophalangeal joint usually has some motion. Such a finger is frequently preferable to an amputated stump. The thumb should never be amputated.

Osteomyelitis was a common complication and occurred in 47 cases or 38 per cent, and was often multiple. The middle phalanx was the one most frequently infected, chiefly because of its central position and frequent involvement with a suppurative arthritis of either the proximal or distal phalangeal joint. This bone was involved in 28 cases. Suppurative arthritis was also frequent and occurred in 36 cases or 29 per cent. The distal phalangeal joint was the joint most often invaded. Not only was it involved secondarily to the sheath but it was often the route by which infections of the distal closed space reached the sheath. The proximal phalangeal joint was the joint most often affected secondarily to infection of the tendon sheath. The metacarpal bone and the metacarpophalangeal joint were the least often involved. The *Staphylococcus* in pure culture was responsible for slightly more cases than the *Streptococcus* (40 per cent as compared to 26 per cent), and was more prone to involve several bones before the infection was arrested. The results in this group, with complicating osteomyelitis and suppurative arthritis, were very poor, as would be expected, and most of the cases fell into Group I. The figures for the incidence of osteomyelitis and arthritis are open to some question but are approximately correct. It was difficult to be sure of the actual involvement in all cases.

Hemorrhage from the radial artery occurred in two cases. One was associated with severe infection and was largely responsible for the patient's death. The other also accompanied a severe infection and recurred several times, finally necessitating upper arm amputation. In the former the use of Dakin's solution and hard rubber tube drains close to the radial artery may have contributed to the hemorrhage. In both these cases the radial bursa above the wrist had become involved and was drained by a lateral incision.

between the flexor carpi radialis tendon and the artery. This incision is more anterior than the one usually made behind the artery and may leave it more exposed to trauma and infection. Kanavel, Deike, and Garlock reported similar complications. Deike and Kanavel had several cases of severe hemorrhage from the ulnar artery as well. Kanavel believes this is the artery usually involved. He emphasizes the danger of severe and even fatal hemorrhage. He believes ligation of the vessel should be done at once and advises against packing the wound or other temporizing measures. Our experience in these two cases confirms his view.

It is of interest that suppurative phlebitis, which occurred only once as a complication, developed in the only case in which Biet's passive hyperemia treatment was tried. This was a toxic case with a severe infection of the radial bursa. Venous constriction was maintained for the first 15 hours after operation by an Esmarch bandage about the upper arm which impeded the venous return but did not obliterate the arterial pulse. A suppurative phlebitis developed later in the median basilic vein and had to be incised. This procedure was formerly extensively used in Germany but in recent years has had fewer supporters. A number of cases of secondary erysipelas have been reported following its use.

There were two cases of gangrene of the terminal phalanx secondary to extensive soft tissue involvement and osteomyelitis. Deike, zur Verth,<sup>11</sup> and others reported similar occurrences in severe and neglected infections due apparently to thrombosis of the vessels in the finger. Deike had ten such cases.

Musculospiral nerve paralysis from the use of an Esmarch tourniquet with temporary wrist drop occurred in two cases. One lasted five months before complete recovery. To prevent this Auchincloss uses at least 18-20 layers of towelling beneath the tourniquet.

One boy, age 8, developed a positive *Staphylococcus hemolyticus* blood culture after operation and a metastatic osteomyelitis of the femur that had to be drained. Deike had five similar cases, all with foci in the bones of the lower extremity. All of his cases died. In only three of our cases was sepsis proven by positive blood cultures. One has just been mentioned, and of the other two, both due to the *Streptococcus hemolyticus*, one recovered and the other died following hemorrhage from the radial artery.

It is significant that the *Streptococcus hemolyticus* was the organism present in most of the cases with severe complications. It was responsible for the only death, all of the upper arm and forearm amputations, two of the eight finger amputations, both cases of secondary radial artery hemorrhage, both cases of local gangrene of the terminal phalanx, the only case of suppurative phlebitis, seven of the nine cases with extension into the spaces of the forearm, four of the five cases of extension to the tendon sheath of the flexor carpi radialis muscle, and the only case with extension to the wrist joint.

Other complications such as involvement of the forearm, the tendon sheath

of the flexor carpi radialis muscle, and the wrist joint will be discussed later with the other extensions of tenosynovitis

*Human Bite Infections* —There were three cases of tenosynovitis secondary to human bites on the dorsum of the hand. In all, the sheath was involved by way of the metacarpophalangeal or interphalangeal joint, and the volar subtendinous space. In only one was the extension of the process to the sheath recognized before the infection was well advanced. All these cases showed extensive tendon slough, osteomyelitis, and suppurative arthritis. In two the finger was amputated. In the third it was advised but not done. The results were all bad. Probably because of the mixed and virulent organisms introduced, these cases are notoriously persistent and disabling. Kanavel and Mason and Koch<sup>15</sup> have recently discussed them at length. Every human bite should be treated with extreme consideration and in most cases admitted to the hospital at once. Mechanical cleansing of the wound should be carefully carried out. Some debridement may be necessary. Incisions should be liberal. Extension to the bones and joint should be watched for and treated accordingly. Unless drainage is adequate there is danger of further extension to the flexor tendon sheath. Because of the presence of anaerobic organisms in the mouth, particularly anaerobic streptococci, spirochaetes, and fusiform bacilli, Meleney<sup>16</sup> advises débridement and flooding of all surfaces of the wound with a creamy suspension of zinc peroxide. This suspension is also used at subsequent dressings.

*Extensions of Tenosynovitis* —Extensions of the infection from the sheath to the fascial spaces of the hand occurred frequently. The thenar space was involved in 15 cases: in ten from the second finger, in three from the first finger, in one from the third finger, and once from the fourth finger via the midpalmar space. The midpalmar space was involved four times: once following infection of the third, fourth, and fifth finger sheaths respectively and once following an infection of the palm. The space between the first dorsal interosseus and adductor transversus pollicis muscles was involved four times as a complication of tenosynovitis of the first and second fingers. In three cases it was associated with an abscess of the thenar space and was apparently secondary to it. In one case the thenar space was apparently not involved. These extensions were similar to those described by Kanavel and Deike.

Extension of infection into the soft tissues of the forearm occurred in nine cases. It followed involvement of the radial bursa above the wrist and combined infection of both bursae above the wrist in three cases each. It occurred once after involvement of the ulna bursa alone, and twice from extension of an infection of the thenar space. In no instance did it follow midpalmar space infection. Most of these were markedly toxic cases. The forearm extension in itself added little to the later disability. Six of the cases showed *Streptococcus hemolyticus* in pure culture, one showed *Streptococcus hemolyticus* and *Staphylococcus*, and in the remaining two there was no culture report. Other authors emphasize also the frequency of forearm infection.

following radial or ulna buisitis Deike had 61 cases All agree that it occurs rarely after thenar space, and almost never after midpalmar space involvement The best approach to these deep forearm abscesses has been recently discussed by Auchincloss

Extension to the tendon sheath of the flexor carpi radialis muscle occurred in five instances In every case it followed involvement of the radial bursa in the palm and above the wrist In one of these the infection spread from the flexor carpi radialis sheath to the wrist joint and extended between the trapezoid and the second metacarpal bone to the dorsal subaponeurotic space The patient recovered but was left with a stiff hand and wrist This was the only case in this series with wrist joint involvement The Streptococcus hemolyticus was present in the culture of four of the five cases, including the one spreading to the wrist joint Disability from involvement of the sheath of the flexor carpi radialis muscle was very slight Involvement of the wrist joint, however, is always a serious complication often necessitating amputation Deike had four cases, of which one died, two had amputations, and one has a stiff, crippled hand Both Auchincloss and Deike believe that the usual route of involvement is from the radial bursa to the sheath of the flexor carpi radialis tendon which inserts into the bases of the second and third metacarpal bones

Extensions from the volar to the dorsal surface of the hand occurred in ten cases In six of them the route was by way of the lumbrical muscles and the webs In four instances it led through the joints, once in the proximal phalangeal, twice in the metacarpophalangeal, and once through the carpus Extension in the reverse direction, from the dorsum to the volar side of the hand, occurred in only three cases These were all human bite infections, spreading by way of the metacarpophalangeal joint twice and the proximal phalangeal joint once These cases emphasize the importance of these two routes of deep infection from one side of the hand to the other Other routes must be very rare In the fingers the insertion of the deep fascia to the sides of the phalanges and to the skin laterally, tends to prevent spread around the finger by way of the subcutaneous tissues

*Surgical Technic*—The incisions were usually multiple, short, and anterolateral, over the proximal and middle closed spaces in the fingers and a single midline incision over the sheath in the palm The bursae above the wrist were usually drained by lateral incisions as advocated by Kanavel The finger incisions were either bilateral or unilateral, and were often given a slight L extension at their distal end for better drainage Finger incisions lateral to the anterior digital vessels have not been used as they would divide the branches from the vessels to the sheath and tendon and might compromise their nutrition In only a few advanced cases, with frankly slough-tendons was a long midline anterior incision across the flexion creases used Recently Auchincloss has suggested the use of truncated flaps for the finger incisions, one for the proximal and one for the middle closed space The flap includes all tissues down to the tendon sheath Its distal end is cut

along the flexion crease. Its sides are cut obliquely to avoid the anterior digital vessels and nerves and extend nearly to the next proximal crease. Its advantage is the better drainage of the sheath. The palmar incision is made as formerly. Ten cases of this series have been incised by this technic with encouraging results. The number is of course too small from which to draw conclusions but the results have been somewhat better than the general average. For deep abscesses extending upward into the interflexor space of the midforearm, the incisions advocated by Auchincloss have been recently used.

Splitting of the anterior carpal ligament, to provide better drainage for suppurative ulna bursitis, was performed on three occasions. These were all advanced cases in which palmar and lateral incisions above the wrist had already been made. All gave poor functional results. Forssell advocated this incision to prevent pressure on the tendons beneath the ligament which he believed was the chief cause of their necrosis. Leibovici and Iselin,<sup>17</sup> on the other hand, condemn this incision. They believe it exposes the tendons without draining the sheath behind them and favors necrosis and contractures. Kanavel advises it only in late cases with necrosis of the tendons or in exceptional instances where excessive pressure on the tendons or on the median nerve is feared. Auchincloss divides the ligament occasionally but believes partial division is often sufficient and prevents prolapse of the tendons.

*Duration of Healing and Hospitalization*—The average time required from operation to complete healing was 53 days. Cases without tendon necrosis averaged 36 days, and those with necrosis 71 days, or nearly twice as long. The average period of hospitalization was 22 days, 17 days for those without tendon slough and 26 days for those with it.

*Localized Tenosynovitis*—In 24 cases, or 19 per cent, the infection proved to be localized to only a portion of the sheath. This limitation was most common in the first and fifth fingers, probably because of the greater length of these sheaths with their associated bursae. In the fifth finger it may have been due occasionally to an anomalous sheath. In seven cases involving the thumb the infection did not extend to the bursa above the wrist. In the fifth finger the localization occurred in different parts of the sheath and bursa. In the other fingers the localization was about equally distributed between portions of the sheaths in the fingers and the palm. A few of these cases may have been incorrectly classed as instances of localized tenosynovitis when they were really very early infections, incised before the inflammation had had a chance to spread throughout the whole sheath. Such errors were probably rare, however. Klapp and Beck<sup>18</sup> believe that the infection is often temporarily checked in the region of the proximal phalangeal and metacarpophalangeal joints and that the entire sheath is usually not involved unless operation is delayed. Since in all but six of our 24 cases with limited involvement the tenosynovitis was definitely of the secondary type, it seems probable that the limited extent of the tenosynovitis was due rather to the tendency of the sheath to wall off the area of its involvement in the face of a slowly invading infection from without.

The incidence of tendon slough in these cases was slightly above that for the whole series and was probably due to the high proportion of secondary cases, which are more liable to tendon slough because of the associated infection outside the sheath. The bacteriologic reports in this group are interesting in that they show a much greater frequency of *Staphylococcus* over *Streptococcus*. In fact only four cases showed *Streptococcus hemolyticus* in pure culture. This emphasizes the more localizing features of the former as compared to the invasive characteristics of the latter. The results in these cases proved to be slightly better than those for the whole series. The advantage of the more limited extent of infection more than offset the greater incidence of tendon necrosis.

*Incompletely Drained Tenosynovitis*—In 28 cases, or 22 per cent, the tendon sheaths were not completely incised although the whole sheath was apparently involved at the time of operation. Seventeen of these had to have their inadequate drainage corrected at a later operation. In a few cases the surgeon apparently felt that adequate drainage of the whole sheath was possible through less than the usual number of incisions. In most cases, however, he was misled by the clinical signs to believe that only a portion of the sheath was involved. This occurred especially in very early cases in which the signs were not as yet definite. The most common mistake was failure to drain the palmar portion of the tendon sheath in infections of the second, third, and fourth fingers. This occurred in 13 cases. Failure to drain the radial bursa above the wrist in five instances was the next most frequent error. Of the cases in which the palmar portion of the sheath was not drained there were four with good results and nine with poor results, five of which were later drained in the palm. Cases with adequate incision in the palm, but inadequate incision in the finger, were less frequent and showed about an equal number of good and bad results. From these figures it would seem as if the palmar portion of the sheath was perhaps the most important to drain. For the three middle fingers, Iselin<sup>10</sup> has recently advocated drainage only in the palm. He believes this method drains the dilated proximal part of the sheath where exudate is most apt to collect and avoids injury to the sliding mechanism in the finger. He makes two volar and two dorsal incisions. There were several cases involving the thumb and fifth fingers in which drainage in the finger and palm was successful without necessitating an incision above the wrist. Failure to drain the bursae above the wrist, however, is hazardous because of the danger of extension to the opposite bursa, to the forearm, and even to the wrist joint.

In this group of incompletely drained sheaths, 18 or 64 per cent showed sloughing of the tendon as compared to 52 per cent in the whole series. The end-results in these cases were slightly poorer than those for the whole group.

*Uninfected Portions of Tendon Sheaths Contaminated at Operation*—The chief reason for the incomplete incision of sheaths was the belief that the infection was localized and the fear that further incision might contaminate a hitherto uninvolved part. This danger of contamination was accordingly



studied There were 12 cases in which the sheath infection was definitely localized but in which uninvolved portions were opened at operation The most frequently uninvolved site in these cases was either the palmar end of the sheath in the three middle fingers or the part of the bursa above the wrist in the first and fifth fingers Eleven of the 12 cases showed no apparent bad effects from this contamination The conclusion is that this danger has been overemphasized When doubt exists as to whether the infection is limited to a part of the sheath or not it is far better to incise the whole sheath even if this may prove to have been unnecessary There is some difference of opinion as to the best procedure in such cases Keppeler advises making the first incision in the doubtful portion of the sheath and draining the portion definitely infected last This perhaps lessens the chance of contamination of the uninvolved portion Kanavel, however, makes his first incision in the sheath where the infection is certain and then carefully incises towards the doubtful portion The presence or absence of exudate on pressure over the unopened portion of the sheath and the clinical signs before operation help to determine the extent of the incision This latter method seems preferable In this way, infections of limited extent are more readily recognized When real doubt exists, however, it is wiser to incise the whole sheath

*Uninfected Tendon Sheaths Contaminated at Operation*—There is no record of the number of cases wrongly diagnosed as tenosynovitis in which the sheath was incised, found to be uninfected, and remained so Unless the sheath became infected subsequently the case would not be listed under that diagnosis There were only four cases in this series which apparently originated in this way In these instances the incision disclosed no pus within the sheath but some in the subcutaneous tissues close to it The sheath was undoubtedly contaminated at operation, but would probably have become involved secondarily anyway Three of these cases showed tendon slough and poor end-results later In the fourth case the infection remained localized and left the hand with perfect function This number is surprisingly small and stands in sharp contrast to the large number of cases in which delay from over caution contributed to the poor end-results It should be emphasized again that when reasonable suspicion of tenosynovitis is present it is far better to incise than to delay A neglected sheath will give much greater disability than one opened unnecessarily

*Causes of Poor Results*—The end-results have been shown to be poor Sixty per cent or nearly two-thirds were unsatisfactory and were placed in the lower two groups Over one-half showed gross tendon slough I have tried to list the causes of the poor results somewhat in the order of their frequency and importance Late operation was the chief of these, due not infrequently to delay in diagnosis in our own Out-Patient Clinic but more often to delay before coming to the hospital Other causes were secondary infection, late removal of drains, incomplete drainage of the tendon sheath, improperly placed incisions, delay in starting active motion of fingers, too early discharge from the hospital, and inadequate supervision of dressings in

the Clinic after discharge. In addition, failure to realize the danger of human bites, neglect of infections of the distal closed space, lack of cooperation on the part of the patient and lowered resistance from associated disease, such as diabetes, should be mentioned. Even when all the causes of poor results were apparently absent, however, the functional result was often poor. The last word has obviously not been said as to the best type of incision, the best method of drainage, and the best postoperative treatment.

*Gonococcus Tenosynovitis*—There were seven cases of gonococcus tenosynovitis during this 17 year period which were not included in this series. The diagnosis was made on a positive wound culture in two instances, on a positive smear from the wound in two cases, and on the clinical symptoms, based on the history of an associated polyarthritis, and a positive prostatic smear in the remaining three. All were hematogenous infections. There were two males and five females with an average age of 23. There was no necrosis of the tendon in any case. Healing was uneventful. In one case in which the diagnosis was confirmed at operation by a positive smear from the sheath, the wound was resutured and healed with a perfect functional result. There were no complications. The average time from operation to complete healing was 20 days as compared to 53 days in the cases caused by other organisms. The average period of hospitalization was only 12 days as compared to a general average of 21 days. The results were almost uniformly good. All the cases had nearly perfect function and were classed in Group IV, except one placed in Group III because of slight limitation of motion in the distal phalangeal joint, and one put in Group II because of a slightly adherent tendon.

#### SUMMARY AND CONCLUSIONS

(1) There were 125 cases of suppurative tenosynovitis in this series followed for an average of over 16 months. *Gonococcus tenosynovitis* was not included.

(2) Hematogenous infection did not occur in any case. No case was infected from another focus on the hand by way of the lymphatics.

(3) The puncture wound was the most frequent injury causing infection, occurring in 51 per cent of cases.

(4) The flexor finger creases were the most frequent sites of injury causing tenosynovitis, especially the distal crease. A wound at the finger creases should be regarded as a threat to the tendon sheath. The distal closed space was the second most frequent site of origin. Late and inadequate drainage of infections of this space leads frequently to tenosynovitis.

(5) Tenosynovitis was most frequent in the first three fingers of the right hand.

(6) Errors in diagnosis caused delay in operation in 25 per cent of the cases and occurred in 13 per cent of those with primary tenosynovitis, and in 38 per cent of the cases of secondary tenosynovitis. The delay averaged one day in primary cases and four days in secondary cases. The accompany-

ing infection in tissues adjacent to the tendon sheath made the diagnosis more difficult in the secondary cases

(7) The end-results were poor. They were classed in four groups based primarily on function. Over one-third of the cases were in the poorest group. Nearly two-thirds were in the lower two groups. Only 17 per cent had complete or nearly complete function. The exclusion of 15 advanced cases with tendon necrosis at operation made very little improvement in the results.

(8) Gross necrosis of the tendon occurred in 52 per cent of cases.

(9) The *Streptococcus hemolyticus* was present at operation in pure culture in 36 per cent of cases, the *Staphylococcus* in 31 per cent. Results were somewhat better in the *Staphylococcus* cases. Mixed infections usually did poorly.

(10) The best results were found in the thumb and the poorest in the fifth finger.

(11) Primary tenosynovitis occurred in 67 cases, or 54 per cent, and secondary tenosynovitis in 58 cases, or 46 per cent. The results in the two groups were about the same. Unless localized to a portion of the tendon sheath, however, secondary tenosynovitis gave a much poorer prognosis. Secondary tenosynovitis was more apt to have tendon necrosis. Primary infections were most frequently caused by the *Streptococcus* and secondary infections by the *Staphylococcus*.

(12) There were 13 cases of radial bursitis, eight cases of ulna bursitis, and ten cases of combined infection of both radial and ulna bursae. All but one of the combined infections spread from the radial to the ulna bursa. Most of these cases were due to the *Streptococcus hemolyticus*.

(13) The average duration of tenosynovitis before operation was 6.2 days. It was nearly three times as great in Group I as in Group IV.

(14) The prognosis became definitely poorer with advancing age. Tendon necrosis also became more frequent.

(15) Sterile wet dressings of saline or boric solution seemed to give better results after operation than sterile hand soaks.

(16) There was one death, a mortality of 0.8 per cent. There were three arm and eight finger amputations. Osteomyelitis occurred in 38 per cent of cases. The middle phalanx was most frequently involved. Suppurative arthritis was most frequent in the distal phalangeal joint. The *Streptococcus hemolyticus* was the responsible organism in most of the severe complications.

(17) There were three cases of tenosynovitis secondary to human bites on the dorsum of the fingers and hand. All showed poor functional results.

(18) Extensions to the thenar space occurred in 15 cases, to the mid-palmar space in four cases, to the forearm in nine cases, and to the wrist joint in one case. Extension from the volar to the dorsal side of the hand occurred in ten cases, in six by way of the lumbricals and webs, and in four through

the phalangeal or metacarpophalangeal joints Extension from the dorsum to the volar side occurred only in the three human bite infections

(19) The average period from operation to complete healing was 53 days It was twice as long in the cases with tendon necrosis as in those without

(20) Localized tenosynovitis occurred in 19 per cent of cases Most of these were secondary infections The results in these cases were somewhat better than the average

(21) In 22 per cent of cases the tendon sheath was incompletely drained Over half of these had to be operated upon again The results in these cases were poorer than the average

(22) Uninfected portions of sheaths contaminated at operation did not influence the results appreciably In doubtful cases it is wiser to incise the whole sheath

(23) Only four cases of tenosynovitis were due to contamination of an uninfected sheath at operation In all these cases the infection lay close to the sheath and probably would have involved it later In doubtful cases of tenosynovitis it is much wiser to operate than to delay

(24) Delay before operation is probably the most important cause of the poor results

(25) Gonococcus tenosynovitis occurred in seven cases during this period All were hematogenous There was no tendon necrosis or other complication The results were all unusually good

#### REFERENCES

- <sup>1</sup> Forssell, W Klinische Beträge zur Kenntnis der akut septischen Eiterungen der Sehnenscheiden der Hohlhand besonders mit Rücksicht auf die Therapie Nord Med Arkiv, 1903, hft 3, No 14, 1, hft 4, No 19, 55
- <sup>2</sup> Keppler, W Zur Klinik der Sehnenscheidenphlegmone unter besonderer Berücksichtigung der Stauungsbehandlung Deutsch Ztschr f Chir, 115, 63, 1912
- <sup>3</sup> Cleveland, M Suppurative Tenosynovitis of the Flexor Muscles of the Hand Arch Surg, 7, 661, 1923
- <sup>4</sup> Garlock, J H Infections of the Hand Surg, Gynec, and Obst, 39, 165, 1924
- <sup>5</sup> Schiessl, M Inzision in den natürlichen Falten der Hand—ein Beitrag zur Behandlung der Sehnenscheiden- und Schwartenphlegmone Munch med Wchnschr, 72, 1728, 1925
- <sup>6</sup> Brofeld, S A Über das Panaritium Duodezimum (Helsingfors), 45, 849, 1929 Abstr Zentralorgan für die ges chir und ihre Grenzgebiete, 48, 783, 1930
- <sup>7</sup> Deike, H Sehnenscheidenpanaritien der Hand, ihre Behandlung und ihr Spatschicksal Brun's Beitr z klin Chir, 158, 461, 1933
- <sup>8</sup> Kanavel, A B Infections of the Hand Sixth Ed, Lea and Febiger, Philadelphia, 1933
- <sup>9</sup> Auchincloss, H Surgery of the Hand Nelson's Loose-leaf Surgery, 3, 459, 1927
- <sup>10</sup> Iselin, M Tenosynovites digitales Schweiz med Wchnschr, 13, 1159, 1932
- <sup>11</sup> Zur Verth, M Das Panaritium Ergebnisse der Chir und Orthopädie 16, 653, 1923
- <sup>12</sup> Poirier P Traite d'anatomie humaine 2, Masson et Cie, Paris, 1896
- <sup>13</sup> Moissejeff, A J Ueber Alterserscheinungen in den Sehnen Munch med Wchnschr, 68, 1538, 1921 (Rep Med Soc, St Petersburg and Moscow Path Soc, St Petersburg, October 13-15, 1921)

- <sup>14</sup> Klapp, R Die Behandlung der Schnenscheidenphlegmone Berlin klin Wchnschr ,  
45, 725, 1908
- <sup>15</sup> Mason, M L , and Koch, S L Human Bite Infections of the Hand Surg , Gynec ,  
and Obst , 51, 591, 1930
- <sup>16</sup> Meleney, F L Zinc Peroxide in the Treatment of Microaerophilic and Anaërobic  
Infections ANNALS OF SURGERY, 101, 997, 1935
- <sup>17</sup> Leibovici, R , et Iselin, M Traitement des phlegmons des gaines carpiennes par les  
incisions laterales et discontinues Journal de Chir , 37, 358, Paris, 1931
- <sup>18</sup> Klapp, R , and Beck, H Das Panaritium S Hirzel, Leipzig, 1923

# PROPHYLACTIC FOOT TREATMENT IN PATIENTS WITH DIABETES MELLITUS

ANALYSES OF ITS EFFECT ON THE PREVENTION OF INFECTION OF THE LOWER  
EXTREMITIES AND THE OPERATIVE PROGNOSIS IN A SERIES OF FIVE  
HUNDRED SEVENTY-SIX CASES

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THE occurrence of infections of the lower extremities in patients with diabetes mellitus is so well recognized that further reference to the subject might seem unwarranted but for the fact that these infections continue to be, frequently, the etiologic factor of diabetic gangrene. The prevention of this complication is the aim of every diabetic clinic and it is because of this that we are reporting the effect of prophylactic foot treatment on the incidence of foot infections in the Diabetic Clinic of the Third (New York University) Medical Division of Bellevue Hospital. The number of active diabetic patients attending this clinic at the present time is 576. An average of 70 patients are seen weekly. Due to the yearly increase in the number of patients attending the clinic the problem of foot infections is important, as this complication often necessitates prolonged hospitalization and financial loss to the patient. Therefore in May, 1933, a foot treatment room was established in the hope of preventing infections of the feet and for the treatment of minor infections not requiring hospitalization. No attempt was made to make oscillometric determinations, but a record was kept of the condition of the feet, including the texture of the skin, the presence of callosities, corns, abrasions, ulcers or infections and the condition of the toenails.

*Set-Up of the Foot Treatment Rooms*—Two rooms are used, one for female and one for male patients. There are four chairs in each room. The personnel consists of a physician in charge of both rooms, one graduate nurse and two clinical clerks for each room. The nurses and clinical clerks are trained in the technic used in the care of the feet. Major surgical work is never done in the clinic, the treatment consists mainly of the care of infected calluses and corns, none of which requires any anesthesia. The foot rooms run concurrently with the clinic and appointments for foot treatments are made so that the patients visit the foot room approximately every six to eight weeks. If any infection is present, weekly visits are required. New patients are treated in the foot room on their first visit.

*Procedure*—Instructions to new patients. Each patient is given a mimeographed sheet of instructions (Table I) consisting of the procedure for daily foot care and of Buehler's exercises. These instructions and the reason for

such care are explained to the patient. The dangers of foot infections, the necessity for properly fitted shoes and warm stockings in cold weather are also gone over.

TABLE I

DIRECTIONS TO PATIENTS

(1) *Care of Feet*

- A The feet should be soaked in a basin of warm soapy water for five minutes every day
- B They should be dried thoroughly with a Turkish towel. Be careful to dry in between the toes
- C They should be massaged with a little alcohol
- D They should be massaged with lanolin, especially the soles of the feet where there are calluses, and the heels. In this way the calluses are softened and will eventually rub off

(2) *Foot Exercises*

- A Sitting on the edge of the bed, point the toes upward and then downward. Repeat this ten times
- B Then make a complete circle with the foot ten times
- C Then raise both legs to an angle of  $45^\circ$ . As a support for the legs, the patient may place a chair upside down on the bed. Leave them in this position for three minutes
- D Then let them hang down over the side of the bed again for three minutes
- E Then place them flat on the bed for three minutes. Cover with blanket

These exercises should be repeated six times. They should be done daily, and if the feet have a tendency to coldness, they should be done twice a day.

*Care in the Clinic*—The patient is seated in a chair and the feet soaked for five minutes in warm soapy water. They are then thoroughly dried and toenails cut. Corns and calluses are cared for as follows. The noninfected calluses are soaked daily and this is followed by massage with lanolin. Where there is accumulated serum under a firm plaque of callus, the plaque is dissected away to remove pressure and an alcohol and boric dressing applied. The patients are instructed to soak the feet several times daily and to apply a clean wet dressing to the area. Corns are treated in the same manner. Particular attention is given to epidermatophytosis, which is treated as follows. The feet are soaked in the usual manner. Care is taken to insure complete drying. Whitfield's ointment containing 1 per cent salicylic acid is applied. This procedure of soaking, drying, and application of ointment is done daily for one week. The ointment is then discontinued for a week. The toes are kept separated by small pieces of gauze and talcum powder is shaken in between the toes. In most cases ulceration clears up by the end of a week, if this does not occur, treatment is repeated. This routine is continued until the ulceration has disappeared.

The treatment of ingrowing toenails depends on their severity. In mild cases in which the nail is inverted the edges are merely raised with an orange stick and small pieces of cotton are inserted beneath it in order to prevent further inversion. In more severe types a triangular section of the side of the affected nail is removed. The apex of this triangle is towards the base.

of the nail This procedure leaves a space which is then packed with cotton in order to prevent the new nail from inverting as it grows out

*Results*—The two year period prior to the establishment of the foot treatment room, May, 1931, to May, 1933, will be referred to as Period I, the period following the inauguration of routine foot treatment, May, 1933, to May, 1935, as Period II During Period I 34 clinic patients were hospitalized because of infections of the lower extremities (Table II) During

TABLE II

## ANALYSES OF CLINIC PATIENTS, 1931-1935

	Period I (No Foot Room)	Period II (Foot Room)
Number of patients	338	576
Total number of visits	4853	6682
Number of patients receiving foot care	none	367
Per cent requiring hospitalization for infection of lower extremities	10 per cent	4.6 per cent

the years 1931 to 1933, 34 patients, who had never been to a diabetic clinic, were also admitted to the hospital with infections of the feet, and during the next two years 26 nonclinic patients were admitted If we consider first the effect of prophylactic foot treatment on the clinic patients (Table III), the number of patients requiring hospitalization for infections of the lower extremities fell remarkably, *i e*, from 10 to 4.6 per cent in spite of a 70 per cent increase in the total census of the clinic The effect goes further than this, as shown by the results of hospital treatment The mortality dropped from 8.8 to 3.7 per cent and the number of patients requiring amputation from 32.4 to 25.9 per cent

TABLE III

## RESULTS ON HOSPITALIZED PATIENTS, 1931-1935

	Clinic Period I		Clinic Period II		Nonclinic Patients	
	No Foot Treatment	Foot Room Treatment	No Foot Treatment	Foot Room Treatment		
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Number hospitalized	34		27		60	
Improved	29	85.3	26	96.3	33	55
Unimproved	2	5.8	none		4	6.7
Died	3	8.8	1	3.7	23	38.4
Amputated	11	32.4	7	25.9	25	41.6
Cause of death						
Postoperative	3		0		16	
Nonoperative	0		1		7	

NOTE—Of 367 patients treated in foot room from 1933 to 1935, only three required amputation

The effect of proper treatment of the diabetes on the outcome of foot infections can be gathered by comparing the clinic treated patients of Group I with the nonclinic patients (Table III) In the group in which neither



the diabetes nor the feet had been treated, 41.6 per cent required amputation and 38.4 per cent of these patients died. In our clinic group prior to prophylactic foot care 32.4 per cent required amputation, and 8.8 per cent died. Obviously, control of the diabetes with a consequent improvement in the state of nutrition of the patient are important factors in improving the prognosis. Naturally, the patient attending a clinic regularly can be hospitalized before infection sets in, and this further improves the prognosis.

Obviously previous control of the diabetes improves the prognosis in a patient with infection of the feet, but if prophylactic care of the feet is carried out systematically at the same time, the prognosis is greatly improved. Care of the diabetes alone improved the prognosis 77 per cent, when prophylactic foot care was added to this, prognosis improved 90.5 per cent.

TABLE IV

CLINIC AND NONCLINIC PATIENTS

*Relation of Infection to Age, Sex, Sites of Lesion and Insulin Requirement*

Relation of Age to Infection		Sites of Lesions		Sex		Insulin	
Age Group	No. Pts						
10-20	0	Great toes	33	Males	61	Pts requiring	
20-30	2	1 with other toes		Females	60	insulin	98
30-40	3	Small toes	32			No insulin	23
40-50	17	1 with great toe					
50-60	33	Foot	24				
60-70	48	2 with other toes					
70-80	15	Plantar					
80-90	3	Callus	8				
		1 with great toe					
		Heel	6				

Several other interesting facts were brought out as a result of this study (Table IV). The major portion of infections occurred between the ages of 50 to 70. There was a definite rise in infections after 40. The large and small toes were almost equally involved, probably because these are the sites where pressure from improper shoes is likely to occur. As far as sex was concerned the patients were equally divided. If insulin can be used as a criterion of the severity of the diabetes, the severe diabetics were four times as liable to infection as the mild cases.

CONCLUSIONS

As a result of these findings it seems justifiable to include prophylactic foot treatment as a routine part of the treatment of patients attending a diabetic clinic, as has long been advocated by Joslin and his colleagues.<sup>2,3</sup> This care involves the recognition of vascular inadequacies of the extremities and their dangers to the diabetic patient. For this reason we believe that such care should always be under the supervision of a physician. When

the foot treatment room was first opened in this Diabetic Clinic the patients considered the procedure time consuming and unnecessary. However, when they saw the importance that the physician attached to this treatment, and became aware of the comfort it afforded them, their attitude changed. They were stimulated to take better care of their feet at home, to do the prescribed exercises and to come into the clinic if anything developed before their next clinic appointment. Now the care is so much a matter of routine to the patients that they can be depended upon to report regularly to the foot room.

Our impression is that the most frequent cause of infection of the feet in these patients is improper shoes. This superimposed upon arteriosclerosis, which undoubtedly exists in patients of the age group most frequently involved, is too much for the resistance of a patient with diabetes mellitus.

#### REFERENCES

- <sup>1</sup> Buerger. Surgical Diagnosis and Treatment by American Authors. Lea and Febiger, 4, 810, 1920.
- <sup>2</sup> Joslin, E. P. Treatment of Diabetes Mellitus. Lea and Febiger, 465-469, 1935.
- <sup>3</sup> McKittrick, L. S., and Root, H. F. Diabetic Surgery. Lea and Febiger, 192-204, 1928.

# ADAMANTINOMA OF THE JAW<sup>1</sup>

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ADAMANTINOMA is a tumor derived from the enamel-forming cells of the dental epithelium. The term is open to some criticism because it implies something very hard, whereas calcification of enamel formation in the tumor is unknown. It has been suggested by Churchill and one of the writers that a more accurate term would be ameloblastoma, and this is approved by McFarland, but it may be difficult to obtain universal adoption of a new name when the older one is so firmly established. In 1931, McFarland and Patterson<sup>1</sup> published a review of 196 cases reported in the literature, and appended a very large bibliography. Since that time there have appeared several articles recording small series of cases. We believe that the series of 16 cases herewith reported is large enough to permit some conclusions.

The tumor is usually multilocular cystic in character, but frequently, especially in its earlier stages, consists largely of solid tissue. The portion of the jaw involved, usually the molar region of the mandible, but not necessarily so, is distended, containing a lobular mass within a bony cavity, which may protrude from the alveolar border or extend into the surrounding soft tissues by perforation of the cortical plates of bone. The growth contains numerous cavities filled with a viscid brownish fluid. The cystic cavities, which vary greatly in size, present a lining with papillary projections which may partly or completely fill the cavity. The septa between the cavities consist of fibrous tissue and sometimes of bone. The cysts possess a lining of flattened or cuboidal cells, and columns of epithelial cells may be found in the fibrous stroma. Columnar cells are seen, resembling the columnar cells of the enamel organ (ameloblasts), these cells surrounding spaces containing a structure having the appearance of stellate reticulum or enamel pulp. These histologic characteristics clearly indicate the derivation of the tumor from the enamel organ (Fig. 1). The epithelial cells have been known to take on invasive properties, thus resembling epithelioma, though metastases are almost unknown. In general, it may be said that the tumor is benign, with remote possibilities of malignancy. It may be found at any age.

*Symptoms and Diagnosis*—A painless swelling is present, usually in the molar region of the mandible, which has slowly been increasing in size. The alveolar border of the jaw is found to be enlarged, the outer alveolar plate being more affected than the inner one. When the tumor is larger, it may have a lobulated surface with thinning of the overlying bone, and feel elastic on pressure. If an opening into a cystic cavity exists, a fluid discharge is

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CHART I  
DIFFERENTIAL DATA ON EPITHELIAL TUMORS AND CYSTS OF THE DENTAL SYSTEM

Tumor	Origin	Pathologic Anatomy	Roentgen Ray	Age	Clinical Characteristics	Prognosis	Treatment
1 Adenomatous (ameloblastoma)	Aberrant growth of epithelial cells which are prototypes of those forming inner layer of enamel organ (ameloblasts)	Cavity in bone divided into numerous compartments by fibrous or bony septa. Some of the spaces are cystic containing fluid others are filled with solid tissue. Epithelium is cuboid or columnar and arranged in strands or alveoli surrounding a stellate reticulum	Cavity in bone divided by fine trabeculae into compartments varying in size	Any age	Painless expansion of bone usually in molar region of mandible, slowly increasing in size. May be an opening into mouth from cystic cavity	Recurrence common unless radical operation is done	For small growths shelling out and curettage may suffice. For larger ones complete resection of portion of mandible involved
2 Dentigerous (follicular) cyst	Cyst lining formed by epithelium of peripheral layer of enamel organ	Single cavity in bone. Membrane is lined with layers of squamous epithelium. Contains thin fluid and the crown of an unerupted tooth projects into the cyst from its bony wall	Clear area of absence of bone with well-defined margins containing an unerupted tooth	Any age but particularly about time of eruption of permanent teeth	Slowly increasing painless expansion of a part of the bone which later may become very thin and give parchment or celluloid-like feeling. Absence of a tooth from the series in the region of the swelling is significant	Readily cured by suitable operation	Operation through flap of gum. Complete removal of cyst with its capsule together with unerupted tooth
3 Dentoperiosteal (dental root) cyst	Abnormal growth of epithelial cell-rests normally present in dental periosteum derived originally from outer epithelial layer of enamel organ (paradental epithelial rests of Malassez)	Cavity in bone about apex of permanent tooth whose pulp has been devitalized. Cavity lined with multiple layers of squamous epithelium and contains fluid with cholesterol crystals	Radiolucent area in bone with clearly defined margins in connection with apex of pulpless tooth or in part of bone from which pulpless tooth has been removed	Adults	Presence of pulpless tooth or history of previous removal of such a tooth. Slowly increasing painless expansion of bone. Puncture allows discharge of clear fluid or pus if secondary infection is present	Readily cured by suitable operation	Flap made in gum. Removal of offending tooth if present. Epithelial lining shelled out in most cases

seen, usually viscid and brownish. Infection may occur, the nature of the tumor being obscured by symptoms of osteomyelitis. A differential diagnosis from purely inflammatory conditions and from other tumors and cysts can usually be made by the roentgenologic appearance, which shows the growth divided by fine bony compartments. Occasionally, it is almost impossible, preoperatively, to differentiate adamantinoma from benign giant cell tumor, osteitis fibrosa cystica, sarcoma, and other conditions.

Chart I gives the data enabling one to differentiate adamantinoma from the other two common types of cysts derived from dental epithelium. Some writers<sup>1</sup> have attempted to show that adamantinoma may develop from a dentigerous cyst. This may be explained by the findings of Churchill,<sup>2</sup> who has recently called attention to the fact that the epithelial lining of a dentigerous cyst may undergo proliferation and assume a histologic picture



FIG. 1—Photomicrograph taken from a section of an adamantinoma of the mandible, showing the different developmental stages of the tumor (Dr. H. R. Churchill).



FIG. 2—Photomicrograph taken from a section of the invading wall of a dentigerous cyst showing general resemblance to structure of adamantinoma. However, note vascularization in spaces, and tendency of epithelium to assume cuboidal and columnar shapes (Dr. H. R. Churchill).

suggestive of adamantinoma, but has shown that there are certain definite characteristics which permit a differentiation to be made. "Proliferations from the wall of a dentigerous cyst may invade the adjoining tissue and form separate epithelial strands which enclose smaller or larger areas of connective tissue. The latter, when entirely enclosed in the proliferating epithelium, may finally simulate the contents of the follicle which characterizes the adamantinoma. The fact that thus far no vascularization has been encountered in the follicles of true adamantinomata constitutes an aid in the differentiation of these invading dentigerous cysts and adamantinomata (Fig. 2). But also, the lining of these enclavements can histologically be differentiated from the lining of the true follicles." It is quite likely, therefore, that many growths have been diagnosed adamantinoma, when they are in reality aberrant dentigerous cysts. In fact, Churchill has pointed out this difference in

some of our own cases. However, the clinical course of these aberrant dentigerous cysts very closely resembles that of adamantinoma, so that for practical purposes of treatment it is just as well, for the present, to regard them as one and the same.

Other conditions in the jaw which clinically resemble adamantinoma very closely, and thus present difficulties in differential diagnosis are (1) Localized osteitis fibrosa, (2) benign giant cell tumor, (3) osteogenic sarcoma, and (4) metastatic growths.

In typical cases all of these are characterized by painless, slowly expanding swelling of the bone, with thinning of the cortical plate and later breaking through this plate and bulging into the soft tissues.

(1) Localized Osteitis Fibrosa.—The jaws, especially the mandible, may be the seat of a localized osteitis fibrosa, unaccompanied by any demonstrable evidences of parathyroid overactivity. Even by roentgenologic examination it is frequently difficult to differentiate from adamantinoma, since the roentgenogram shows a moth-eaten or honeycombed condition of the bone, with well-defined margins, and areas with larger spaces. The presence of several areas of this kind in the same bone would make the diagnosis of osteitis fibrosa more probable.

(2) Benign Giant Cell Tumor.—It is probable that this is a stage of osteitis fibrosa. When starting in the interior of the bone, usually the mandible, the tumor causes an expansion of the outer and inner plates. In the presence of a slowly enlarging, painless, expansile swelling of the bone, the possibility of a benign giant cell tumor should be considered. If the cortical plate of bone becomes perforated by the tumor, the mass seen in the mouth will have a typical purplish color. Otherwise, absolute diagnosis may not be possible before operation. On incision, the benign giant cell tumor has a characteristic dark red color, as contrasted with other tumors whose color is usually a pale gray.

(3) Osteogenic Sarcoma may clinically resemble adamantinoma, but usually develops more rapidly, and the outlines of the growth as seen roentgenologically are usually less well defined.

(4) Metastatic or Secondary Growths may occur in the jaw bones, especially the mandible, just as in other bones, from malignant tumors of other tissues of the body. The primary growth is usually carcinoma, and may occur in the breast, thyroid, intestine or other organs. These secondary growths in the jaws cause swellings similar clinically, and sometimes roentgenologically, to those produced by adamantinoma and other tumors mentioned. They may be suspected to be metastases in patients with a history of a malignant tumor elsewhere. On the other hand, recognition of the jaw metastasis may lead to search for a hitherto unsuspected primary growth, as in a recent case of malignant papilloma of the rectum. We have also seen a jaw metastasis from a thyroid tumor, undiagnosed clinically.

Of 16 personal cases of adamantinoma, 15 involved the mandible and one

the maxilla Seven occurred in males and nine in females Eleven were white persons and five were Negroes

*Treatment*—It is very important that every particle of the abnormal epithelium be removed, as otherwise recurrence will surely follow In early cases, when the tumor is small and surrounded by well-defined bony walls, it is sometimes possible to obtain a cure by enucleation and curettement, without complete resection and solution of continuity of the mandible, but even in these cases, recurrence is not infrequent Pichler<sup>4</sup> calls attention to the fact that resection in continuity of the lower jaw is a serious and mutilating operation, and only justifiable as a last resort in the treatment of a benign tumor such as adamantinoma He has obtained good results by enucleation and curettement, followed by packing, and, five to seven days later, the direct implantation of radium into the bone cavity On the other hand, Rosenthal,<sup>5</sup> Simmons<sup>6</sup> and others advocate complete resection in all cases In our experience, while conservative treatment has occasionally been successful, several cases treated by enucleation and curettement have suffered a recurrence and have eventually been cured by complete resection There is no doubt that, when the tumor is large, with irregular extensions into the surrounding bone or perforation of the cortical plates into the soft tissues, complete resection should be the initial treatment Of 15 patients in whom the mandible was involved, three are believed to be well after conservative enucleation, repeated several times in one case Two patients are apparently well after a second conservative enucleation followed by implantation of radium In five cases, complete resection with loss of continuity of the mandible was the initial treatment, with complete cure Five cases, recurring after conservative operations, have finally come to radical resection, with apparent cure In several cases, three to six months after resection of the tumor, the continuity of the mandible was restored by a bone graft from the crest of the ilium

**Case 1**—L T, male, age 43, bank clerk First seen May 15, 1933 Five years ago had an operation for unerupted mandibular third molar and what was diagnosed as a dentigerous cyst About six months ago first began to notice a painless swelling of the gum in the region of the left angle of the mandible, gradually becoming larger, until it finally became noticeable externally

Examination showed a smooth, hard enlargement of the region of the left angle and ascending ramus of the mandible, visible externally In the mouth there was a bulging of the gum due to expansion of the bone in the region formerly occupied by the second and third molars and extending backward into the ramus There was practically no interference with the movement of the lower jaw

Roentgenologic examination showed a multilocular cystic condition involving the left body of the mandible from just behind the first molar tooth and extending posteriorly to involve most of the ascending ramus (Fig 3) Clinical Diagnosis Adamantinoma

*Operation* May 19, 1933, at Graduate Hospital under avertin-gas anesthesia Preliminary ligation of left external carotid artery through transverse incision two fingers-breadth beneath lower border of mandible Another incision was made along the lower border of the mandible from angle to premolar region, and the soft tissue attachments

were dissected free from the bone and the tumor. The bone was sectioned with a Gigli saw just posterior to the first molar and disarticulated at the glenoid fossa. The open-



FIG 3—(Case 1) Roentgenogram showing multilocular cystic adamantinoma of body and ascending ramus of left mandible

ing made through the oral mucous membrane was closed with catgut sutures, and the cavity left by removal of bone and tumor was packed with gauze. The external wound was partially closed in layers, but sufficient opening left for later removal of the gauze



FIG 4—(Case 2) Roentgenogram showing unilocular cystic in mandible due to adamantinoma (Doctors Pancoast and Pendergrass). The tissue between the vertical lines was resected.

FIG 5—(Case 2) Specimen removed at operation

The upper and lower teeth were wired together in occlusion to preserve their relationship as far as possible. This procedure also helps to keep the airway free by preventing collapse of the lower jaw and tongue.



During the next few days the gauze packing was gradually withdrawn through the external incision, which, after some drainage of pus and saliva, closed completely in about three weeks. The wires were removed from the teeth after eight weeks. At first, the remaining part of the mandible tended to drift toward the left, but, with use, the patient gained more power and was eventually able to maintain the correct occlusion.



FIG 6—(Case 2) Roentgenogram made after resection of involved portion of mandible (Dr Carl Kornblum)



FIG 7—(Case 2) Roentgenogram showing bone graft from crest of ilium to restore continuity of mandible (Dr Carl Kornblum)

It was considered unnecessary to attempt either surgical or prosthetic restoration of the missing bone.

Pathologic examination, by Dr E. A. Case, of the tissue removed at operation showed typical adamantinoma. The patient was living and well two years after operation.

**Case 2**—Female, single, age 22. Was first seen in January, 1934, at the University Hospital, where she had been admitted on account of a swelling in the mouth posterior to the lower right third molar region. The lower right second and third molars had been removed about a year previously, on account of soreness and gradual loosening. Since the extraction the third molar socket had never completely healed, and a painless



FIG 8—(Case 2) Photograph of patient after operation, showing little or no disfigurement



FIG 9—(Case 2) Showing normal opening of mouth after operation

swelling, slowly increasing in size, remained on the gum in this region. Examination revealed a smooth soft bulging of the gum over the lower right third molar region, evidently connected with the bone. Roentgenologic examination (Fig 4) showed a smooth, oval cavity with well-defined margins in the angle formed by the ascending ramus of the mandible and the alveolar process, about 2 cm in diameter. A tentative diagnosis of dental cyst was made, and the cavity was opened intra-orally and its con-

tents curetted out by Dr Thomas Cook. The pathologist reported the tissue to be adamantinoma. The patient was discharged from the hospital and instructed to return for reexamination in three months. On May 30, 1923, with the intraoral swelling still present, a roentgenologic examination revealed a persistence of the cavity in the bone, with no diminution in size. Radical operation was then advised.

*Operation*—June 7, 1934, at the Graduate Hospital. Avertin-gas anesthesia. Preliminary ligation of right external carotid artery through transverse incision. An incision was then made at the right lower border of the mandible, curving back slightly around the angle and extending anterior to the facial artery notch. The outer and inner surfaces of the ascending ramus were denuded of soft tissues. The bone was divided anteriorly through the third molar region with a Gigli saw, without entering the mouth, and posteriorly a vertical section was made from the mandibular (sigmoid)



FIG 10—(Case 3) Large multilocular cystic adamantinoma of left mandible (Dr L M Ennis)

notch above to about 15 cm in front of the angle below. The intervening portion of bone was removed, including the coronoid process, after dividing the soft tissue attachments. On the inner aspect of this piece of bone an indurated mass of pathologic tissue extended into the internal pterygoid muscle, peritonsillar and soft palate regions. In removing it a small opening was made through the mucous membrane of the mouth. In the portion of bone removed was a cavity containing pathologic soft tissue. There was a large perforation in the inner aspect of the bone and a smaller one externally (Fig 5). Immediately after the operation the patient's jaws were fixed by wiring the upper and lower teeth in occlusion. After ten days she was discharged from the hospital with the fixation maintained on the teeth. The external wounds healed uneventfully. Pathologic examination of the tissue confirmed the previous diagnosis of adamantinoma.

The patient returned for examination in September, 1934. Teeth were found fixed in good occlusion. Incisions healed, no evidence of return of the growth or presence

of infection. Roentgenograms showed a gap in the bone corresponding to the portion removed at previous operation (Fig 6). Under ether anesthesia the scar beneath the right lower border and angle of the mandible was opened, the bone ends were exposed and freshened, and the gap between them was bridged by a graft from the crest of the right ilium, 3 cm long, fixed in place by fine brass wires passed through holes drilled in the bone ends and in the graft. The overlying soft tissues were closed without drainage. Healing was uneventful. The patient left the hospital 12 days later, without disability, the teeth being still wired together (Fig 7).

Patient returned for examination in October, 1935. There were no signs of recurrence of the tumor, solid union of the jaw had occurred, with normal masticatory function, and there was no noticeable external deformity (Figs 8 and 9).

**Case 3**—J. L. Colored, age 40, laborer. First seen March 21, 1934. Six years ago he began to have swelling of the left side of the lower jaw. This had gradually increased in size. It was painless until recently, when the gum became sore from the upper teeth biting into it. He has had the molar teeth removed on that side at different times and on one occasion the swelling was opened by an incision in the mouth.

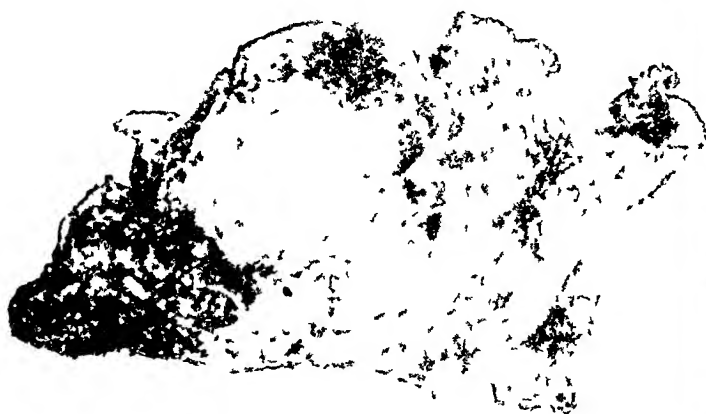


FIG 11—(Case 3) Specimen removed at operation, extending from left condyle to premolar region



FIG 12—(Case 3) Photograph of patient after operation, showing ability to occlude teeth

Examination showed a very large swelling over the left side of the mandible from the mental foramen region back. This was fairly hard, clearly involving the bone, with the soft tissues stretched over it, but it yielded to pressure in places. No tenderness on palpation through the skin. Inspection of the mouth showed a nodular bulging of the mucous membrane over the left side of the lower jaw, and this was inflamed in places where the upper teeth bit into it. There was a small opening in the mouth, through which fluid escaped.

Roentgenologic examination showed enlargement of the entire left side of the mandible, from the mental foramen region extending well up into the ascending ramus. The cortical portion of the bone was very thin in places and the entire area showed spaces of various sizes divided by bony septa. In the center was a mass representing an unerupted molar tooth (Fig 10). Clinical Diagnosis: Adamantinoma.

**Operation**—March 23, 1934. Graduate Hospital. Ether anesthesia. Ligation of left external carotid artery. Resection of left side of mandible from mental foramen to joint (Fig 11). Upper and lower teeth wired together with ligatures, to maintain relationship of remaining lower teeth to those of upper jaw. The wires were removed on March 31, and it was found that he had sufficient control to bring his upper and lower teeth into occlusion (Fig 12). The wound, which communicated with the mouth, healed.

after about four weeks. Pathologic examination, of the tissue removed at operation, confirmed the clinical diagnosis of adamantinoma.

**SUMMARY**—Of 16 cases of adamantinoma 15 involved the mandible and one the maxilla. Seven were in males and nine in females. Eleven were white and five Negroes. Four were treated by conservative enucleation, two by conservative enucleation followed by radium, five by primary complete resection with loss of continuity of the mandible, five by secondary complete resection after recurrence following conservative enucleation.

#### CONCLUSION

From these results, it would seem that primary complete resection is the method of choice in the great majority of cases.

#### REFERENCES

- <sup>1</sup> Cahn, L. R. *Dental Cosmos*, 75, 889, 1933.
- <sup>2</sup> Churchill, H. R. *Dental Cosmos*, 74, 1173, 1934.
- <sup>3</sup> McFarland, J., and Patterson, H. M. *Dental Cosmos*, 73, 656, 1931.
- <sup>4</sup> Pichler, H. *Arch f klin Chir*, 140, 101, 1926.
- <sup>5</sup> Rosenthal, W. *Arch f klin Chir*, 147, 248, 1927.
- <sup>6</sup> Simmons, C. C. *ANNALS OF SURGERY*, 88, 693, 1928.

# UNUNITED FRACTURES OF THE SHAFT OF THE HUMERUS

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REPORTS of end-results in any large series of ununited fractures of the humerus are so exceedingly rare that an analysis of 50 cases may be of interest

Delayed union and nonunion occur in a higher percentage of fractures of the shaft of the humerus than in any other long bone. This is due to two factors: first, the utter impossibility of complete immobilization by any type of external apparatus, second, the difficulty in maintaining complete coaptation of the fragments and preventing a definite space between them which may exist despite a good anatomic alignment. Engagement and locking of the fragments in the humerus is rarely as secure as in the femur because the soft tissues are more relaxed. In our series of 226 ununited fractures of the long bones which were treated by massive onlay graft to be described later, there were 53 in the tibia, 32 in the femur, 52 in the humerus and 89 in the forearm (considering each bone as a separate surgical equation). Nonunion is observed more frequently in the tibia and forearm but fractures of the shaft of the humerus are of much less frequent occurrence, which accounts for the relatively small number but higher percentage of nonunion. Of 4,000 fresh fractures of the shaft of the long bones the distribution was as follows: leg, 1,066, femur, 758, forearm, 1,883, humerus, 293.

When nonunion occurs in the shaft of the humerus, failure to secure union is more frequent than in any other long bone, which is quite evident from the record of many operative attempts without success, often by well trained and able surgeons. Sever has recently reported a series of his own failures and calls attention to the fact that the procedures commonly employed are inadequate. He advises methods that give more accurate and definite fixation.

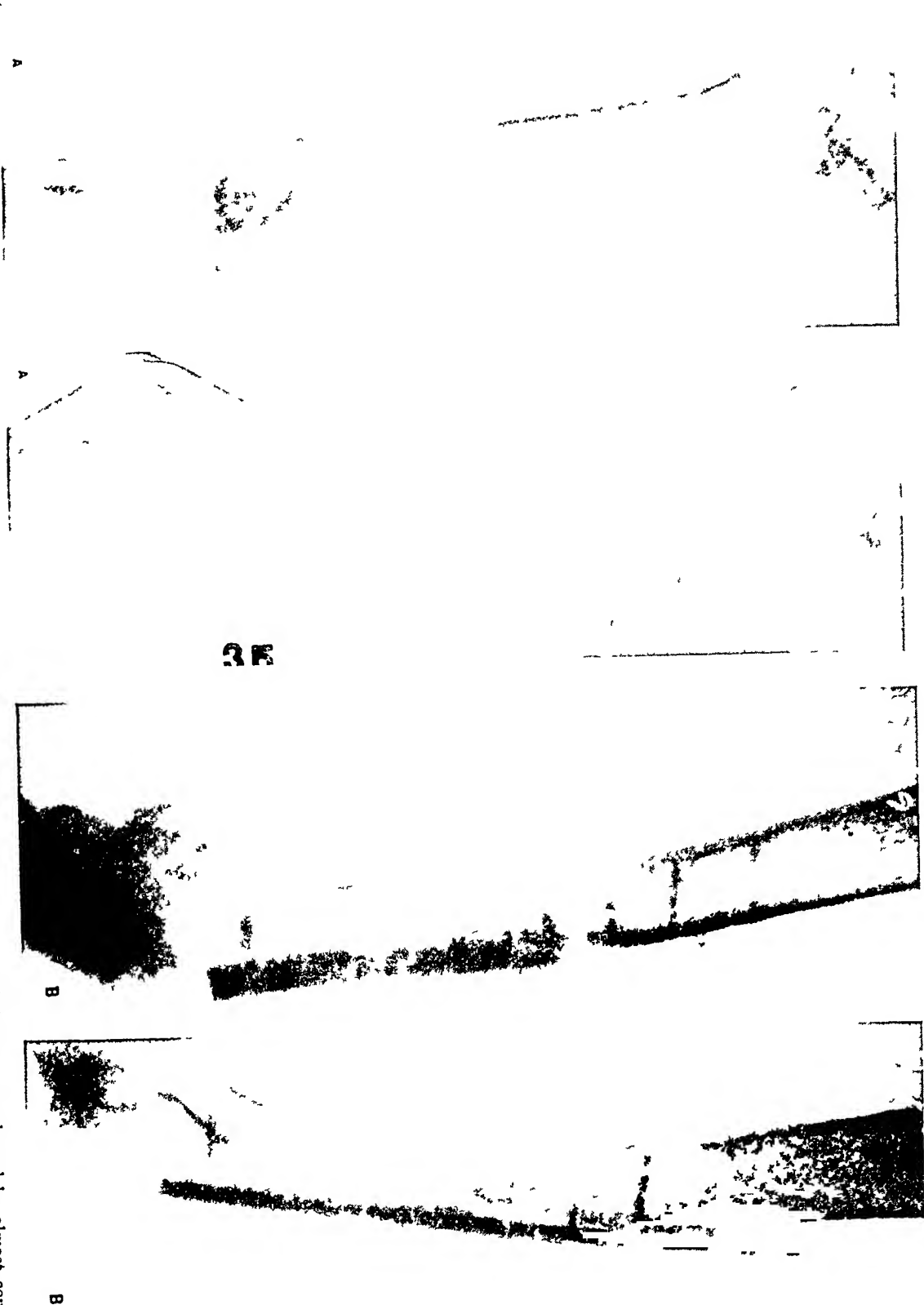
A fracture should not be designated as ununited until it has reached a definite status in the local reaction, so that union is impossible or very improbable. In the humerus, I believe such a state is reached somewhat earlier than in the other long bones. In a very high percentage of fractures of the humerus properly treated, union may be solid by the end of six weeks. In a smaller number there will be delayed or partial union at this time, when further immobilization will usually induce consolidation. If there is no evidence of union at eight weeks, as determined mainly by physical examination, since roentgenograms rarely give material aid as to the degree of union at this time, union can often be obtained by prolonged fixation, but in many a permanent status of nonunion results, therefore, it is often debatable whether

it would not be better to induce union by more definite and certain methods than to submit the patient to the probability of prolonged treatment

The causes of nonunion may be classified as constitutional and local. The constitutional causes are (1) Constitutional diseases, (2) metabolic and endocrine imbalance, (3) diet, (4) multiple fractures, and (5) congenital abnormalities of the bone structures. Syphilis is frequently given as the cause of nonunion, but I have rarely found this affection to be the etiologic factor even in fractures in the parasyphilitic stage, or in any other systemic affection. The imbalance of the calcium-phosphorus product has been considered as a factor in nonunion. Undoubtedly the hyperactivity of the parathyroid gland, the hormone of which apparently controls calcium balance in the bone and other tissues, is the causative factor in osteitis fibrosa cystica. In this affection the calcium is absorbed from the bone with an increased calcium of the blood. In rickets the amount of calcium is decreased in the bone, but in neither of these conditions is osseous union delayed or prevented. Routinely, the blood calcium and phosphorus were determined in possibly 25 cases of ununited fractures, and the calcium-phosphorus product was normal in all. Henderson of the Mayo Clinic, and Kellogg Speed of Chicago report the same experience. Undoubtedly, after any fracture or major traumatic lesion, all agree that the patient should be placed in the best physical condition by the eradication of the foci of infection, treatment of such conditions as syphilis if present, and administration of adequate diet, *etc.* Diet is frequently adjusted to induce callus formation, also various drugs are administered, such as calcium and viosterol. I have observed many ununited fractures in which such measures had been employed without apparent benefit. However, a well balanced diet, which can be assimilated by the patient, is conducive to any healing process. In multiple fractures union progresses satisfactorily in several, but the process of repair is often delayed or fails in one or more. In 1923, I called attention to multiple fractures as a causative agent of delayed union or nonunion, for which there is sufficient evidence to support this clinical observation. Just how multiple fractures delay or prevent union is merely speculative, but it is probably due to a demand of bone production in excess of nature's ability to supply. This condition is the only one in which there is definite clinical evidence of a constitutional factor as a cause of nonunion. Nonunion very rarely may be observed in those with congenital deficiency in the quality of bone as evidenced by condensation. Possibly this may be a mild Albers-Schönberg disease or congenital abnormality. It is possible that endocrine imbalance and other constitutional factors may affect the local process of bone repair sufficiently to be the deciding element between delayed union and nonunion, therefore, it should be given due consideration.

The local causes are any factors which may impair the delicate process of repair, and I am certain, with exceedingly rare exceptions, they are the etiologic agent. In 1932 I analyzed 104 ununited fractures of the long bones, in which solid osseous union was induced in 92 per cent. The failure in the

Fig 1—Ununited fracture of the lower third of the humerus in a patient 46, 52, with marked atrophy of distal as evidenced by almost complete loss of the cortex. Note conical shape of the ends of the fragments. (B) Solid union 14 months after only bone graft



remaining 8 per cent was due to definite local causes. As stated in former contributions, there has been a vast increase in the number of ununited fractures that cannot be entirely accounted for by the increase in the number of fractures, this is due to several local causes *ie*, (1) More severe trauma with greater injury to the surrounding soft parts, (2) a greater number of compound fractures in which union is often delayed, (3) repeated forcible



FIG 2—(A) Extensive osteoporosis with nonunion which shows a definite loss of lime salts quite a different appearance from atrophy of disuse. (B) Solid union six months after operation.

attempts to secure manual reduction, (4) operative measures always impair union but frequently prevent union when employed without due regard to tissue conservation, (5) excessive traction by the improper use of the more modern methods of skeletal traction, (6) interposition of tissue and malposition, (7) sclerosis of bone following an old healed pathologic process, as



in osteomyelitis, (8) fixation by foreign bodies, such as Lane plates, and (9) inadequate immobilization

In order to appreciate the rationale of these local causative agents a brief consideration of the delicate process of repair will be discussed. There are two theories of bone repair, the cellular and the physiochemic, but from a

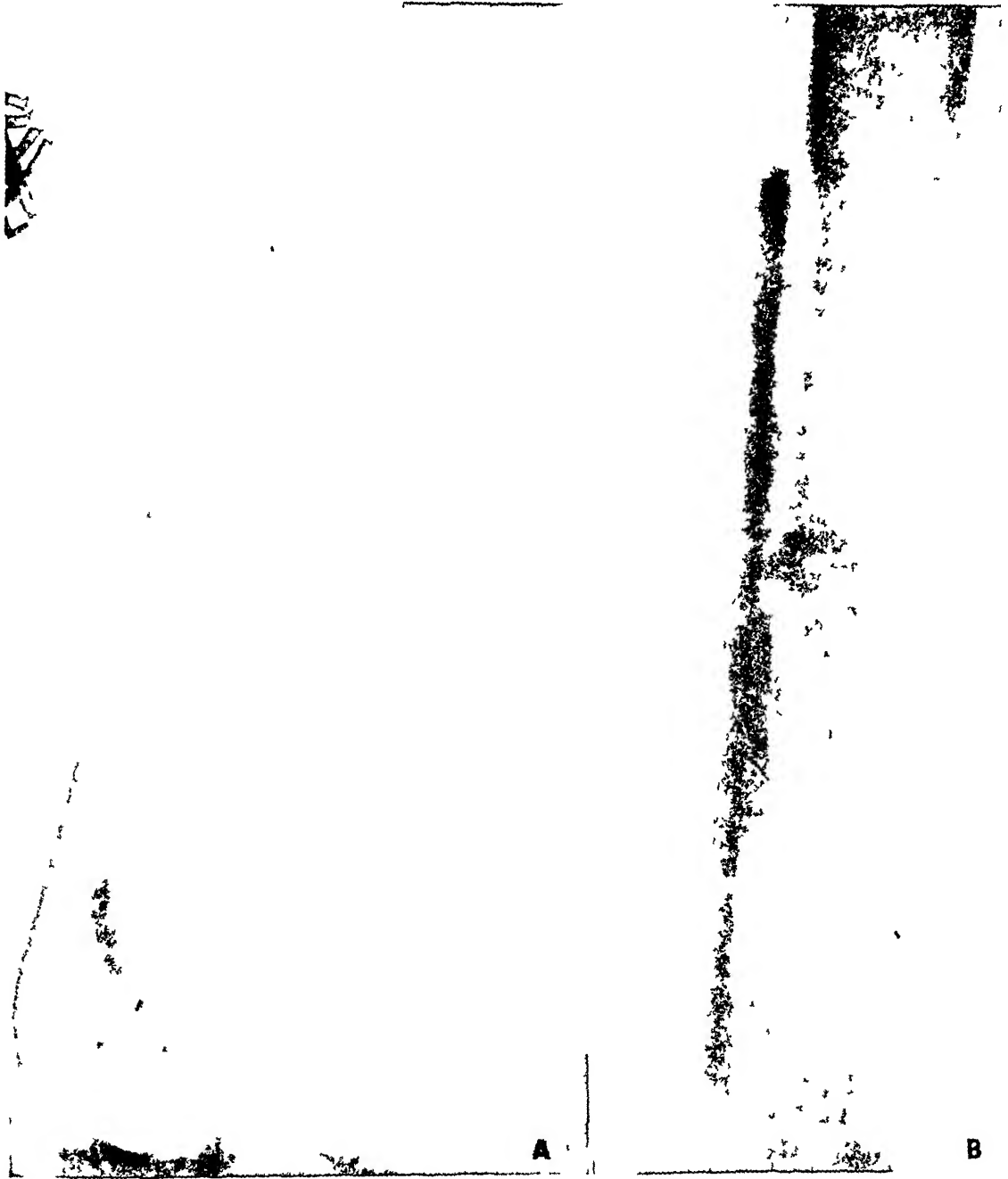


FIG 3—(A) Typical pseudoarthrosis seven months after fracture with concavity on the upper fragment (B) Solid union three months after operation with slight separation of the graft in the upper fragment

practical point of view it makes no difference which of these one may adopt. There are three essential factors involved in osteogenesis, namely (1) the formation of a coagulum between the fracture surfaces—the so called clot in which there is a state of stasis or aseptic necrosis, (2) an adjacent adequate supply of calcium from the fragments, and (3) surrounding the area of

stasis with free calcium supply there must be an excessive blood supply, induced by the stimulus of injury. A combination of these three factors is conducive and essential to the formation of the delicate process of repair. Osteogenesis, or bone repair, is comparable to that of fibrous tissue. It involves a complicated embryologic evolutionary process, in which may be formed various types of tissue, as preosseous, hyaline, osteoid, cartilage and true bone. The chief difference between the formation of granulation tissue



FIG 4—(A) Inefficient intramedullary graft with nonunion (B) Solid union nine months after operation

and bone is the infiltration of calcium. Bone is, of course, a connective tissue and any interference with repair may easily induce the substitution of dense adult fibrous tissue.

In the process of bone repair there are two factors of importance: osteogenesis, and osteolysis and osteoclasia—or bone production and bone dissolution, respectively—which must be well balanced to form true bone. Osteolysis is the absorption of the products of osteogenesis by some chemical agent in the tissue fluids. Osteoclasia is the destruction of bone by the giant cell

osteoclasts, which become active and increase in number after irritation or inflammation. If for any reason bone dissolution is impaired, there will be excessive callus but of low grade quality. If osteoclasia or osteolysis is increased there will be more or less dissolution of callus, if formed, or the prevention of the formation of callus. A fracture may appear to be solidly united, clinically, but after a few days undergo complete dissolution and finally reach a state of hopeless nonunion. If there is excessive local trauma



FIG 5—(A) Inefficient attempt to apply onlay graft with screws, resulting in non union and extensive osteoporosis. (B) Solid union two years after bone graft. Extensive osteoporosis necessitated use of one wire loop.

from repeated attempts to reduce the fracture, the coagulum with new embryonic cells and fibrils of repair may be extruded, or the surrounding circulation, which passes from the soft tissues through the periosteum, may be severed. The mere incision into a fracture delays union to some extent, as can be proven by a comparison of the time of consolidation between closed and open reductions. If the periosteum and soft parts are stripped from both

fragments, delay is increased and nonunion often induced. The coagulum is always lost in open operation. If the circulation is also obliterated, two of the prime factors in osteogenesis have been destroyed. Excessive skeletal traction not only may, but often does, delay union or cause nonunion by mechanically impairing the local process, as it is obviously more difficult for nature to bridge a definite space. Interposition of tissue may act in the same manner. Close approximation of fragments is conducive to union.

Methods commonly employed in the treatment of nonunion of the humerus may be enumerated as follows: (1) The denuding of osseous surfaces and approximating with absorbable or nonabsorbable suture, as wire, (2) steel plate, (3) plastic step-up or dovetailed wedging of the bone with or without suture and pegs, (4) drilling of the fragments, and (5) various types of inefficient bone grafts, as chip graft, Delagenière graft, pegs and intramedullary grafts. This is the type of operation most frequently observed in the history of about 50 per cent of ununited fractures, and undoubtedly in many cases is the actual causative agent of continued nonunion. Union is induced in some instances despite such measures, but the question is not what nature will occasionally accomplish but by what means osseous fusion can be obtained in the highest percentage of cases. In merely delayed union, fusion can be secured by simple drilling of the fragments, or at times by other methods of local irritation, but in true nonunion such methods as above described should not only be discarded but not tolerated, as the percentage of failures is entirely too high.

The inlay method of bone graft is far superior to those above mentioned, but has the disadvantage of removing a considerable portion of the circumference of both fragments from which union is to be secured, and also, in my experience, internal fixation cannot be obtained. A similar method employed by Gill of Philadelphia and Sherman of Pittsburgh secures excellent fixation with the use of large sliding grafts and steel screws. The disadvantages are the removal of large grafts from the fragments and the employment of foreign bodies.

In 1921, after average success in the treatment of ununited fractures, I came to the conclusion that there might be an improvement in the end-results by a method which would permit absolute fixation and at the same time promote osteogenesis. I had previously employed massive intramedullary grafts, inlay and sliding grafts, which are far more efficient than methods above described, but after these procedures motion at the fracture site could always be detected. In consequence, I adopted the following operative technic in ununited fracture of the humerus and other long bones, which has not been changed since first devised.<sup>1</sup>

**OPERATIVE TECHNIC**—An ample incision is made on the anterolateral aspect of the arm about eight inches long. Routine dissection is made through the brachialis anticus and the biceps. The site of the fracture is exposed just beneath the brachialis anticus where possible, but when this muscle is unduly large the outer fibers are severed. All intervening scar and fibrous

# UNUNITED FRACTURES OF THE HUMERUS



Fig 6—(A) Nonunion of a long spiral fracture (which usually occurs). (B) Solid union six months after operation. Ligaments in situ with interosseous bone nubs. No graft necessary.



Fig 7—Notice in this and other cases increased dimension and strength is obtained by the only method.



Fig 8—Failure to obtain union due to technical error. Note separation of ends of fragments.

tissue is removed, the fragments are paired with a chisel or motor saw, and each medulla is reamed out until the normal relationship has been restored. An incision is made through the periosteum of each fragment for several inches, depending on the location of the fracture. The periosteum is stripped from one-half to three-fourths of an inch from the circumference, leaving the soft parts, from which the circulation is derived, attached as much as possible. With a chisel "shavings" are removed from the circumference until there is a continuous flat surface, for three or four inches when possible, on each fragment. A broad, flat, massive graft is taken from the opposite tibia, which should be of sufficient length, breadth and dimension to secure firm fixation. With the motor saw the graft is split longitudinally



FIG 9—"Shavings" are removed from the circumference until there is a continuous flat surface for three to four inches on each fragment

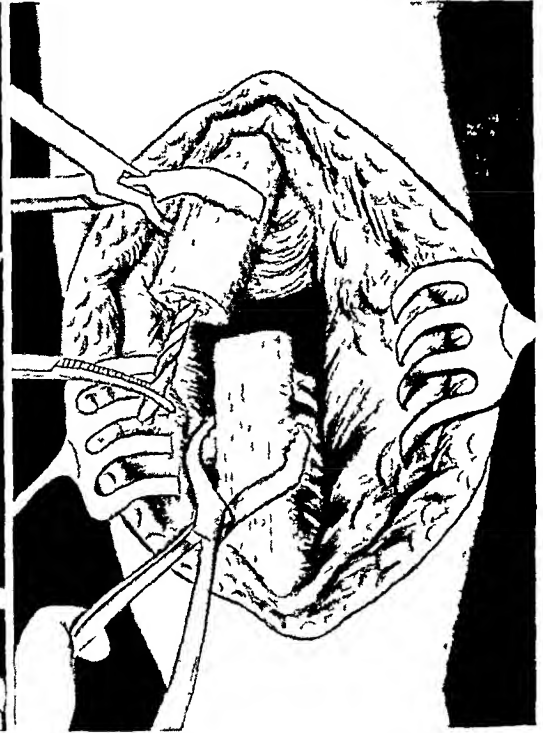


FIG 10—Each medulla is reamed out

through the edge or small diameter into two parts, a strong outer plate consisting of dense bone or cortex, and an inner, the endosteum. A strip of endosteum is placed within the medulla, bridging the site of the fracture as reduction is made, normal marrow tissue rich in osteoblasts, being thus restored. From the outer plate, or as a separate graft, a strip of dense bone is taken, from which six or eight autogenous bone nails are made of appropriate size. This is accomplished by the aid of a rotary file attached to the motor saw and a metal gauge to measure dimensions. The strong outer plate is held to the flat surface of the bone passing across the site of the fracture. Three or four drill holes are made through the graft, into which the autogenous nails are driven. The remainder of the endosteum is broken into small particles and placed with the "shavings" about the site of the fracture.

Spongy bone is always available from the upper extremity of the tibia and can be obtained by a sharp bone curet. About six pieces are removed in this manner and placed around the area of the fracture. Spongy bone is more proliferative than any other type of graft, being 100 per cent successful in an operation which I devised for a type of paralytic foot. The transplantation of endosteum to the medulla and cancellous bone about the fracture is an excellent method of promoting osteogenesis. By this operative procedure solid fixation is attained at the fracture site, when the operation is complete, no motion is apparent. In ununited long oblique fractures of the humerus, which are rare, the onlay technic is unnecessary, as complete fixation can be obtained by transfixation of the fragments with autogenous bone nails.

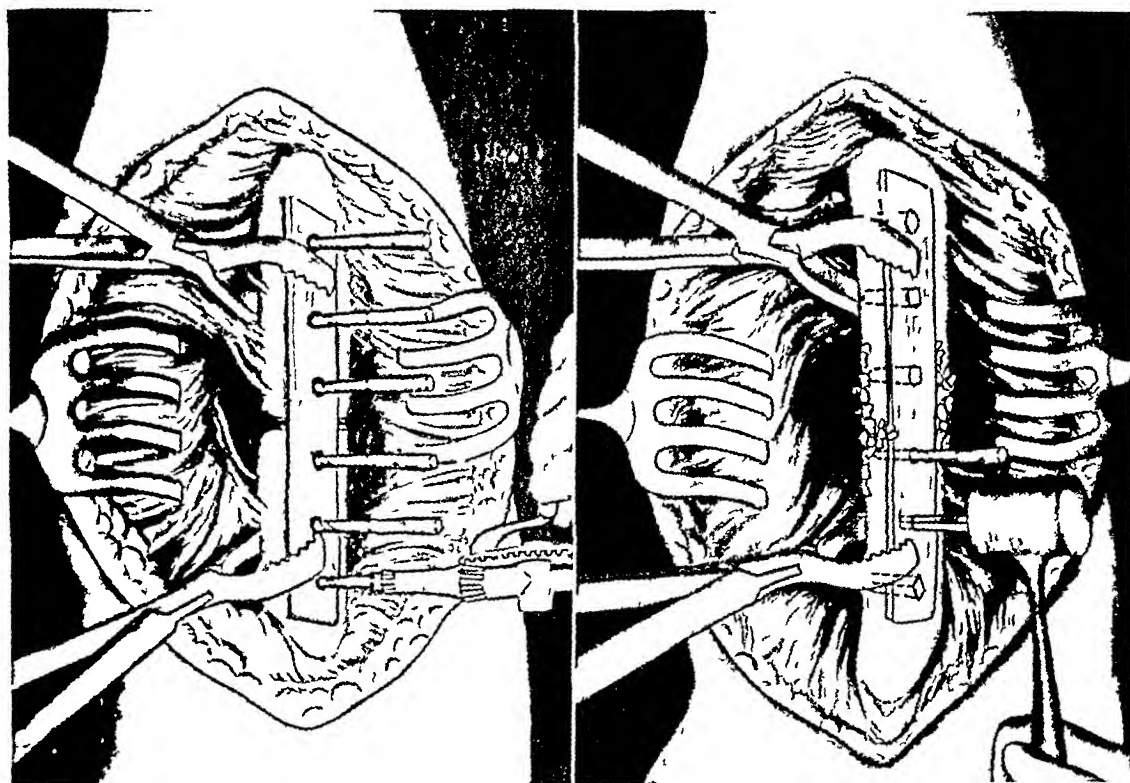


FIG 11—Graft consisting of dense bone or cortex with drills in place

FIG 12—Autogenous bone nails of appropriate size inserted into drill holes

The principles of this method are the same as those of M. S. Henderson from which the technic was devised, but differ in that the cortex is not removed from the fragments, autogenous nails are used and not beef bone screws, cancellous and endosteal bone is used to promote osteogenesis.

After the operation is completed a plaster of paris encasement is applied from the lower margin of the ribs over both shoulders down to the knuckles on the affected side. In an obese patient the cast begins below the crests of the ilium. In those with normal bone structure a special traction humerus splint may be sufficient while the patient is confined to bed, but a plaster cast is employed when ambulation is allowed. The patient is permitted to walk at the end of three weeks. At the end of eight to ten weeks the cast is removed and a leather corset similar to the cast is applied with a joint at the elbow to permit early motion. The site of the fracture remained solid after the

operation in practically every instance which terminated successfully, not the slightest motion being detected at the end of eight weeks or thereafter. However, protection of some type should be used for four to six months, commensurate with the healing of the individual case. Active motion may be employed at the end of three months or earlier. One case, in which the same procedure was employed in both bones of the forearm, left the hospital without permission within 24 hours after operation. After a few weeks he discarded all apparatus and the final result was solid union and perfect function. However, the process of bone repair which is decreased in all fractures with nonunion must be carefully guarded until there is complete consolidation. If the already deficient process is impaired from undue strain, there may be a stimulation of the process of bone resorption which causes

complete dissolution and a return to the former state of nonunion. Also from slight injury the graft may be fractured, which likewise defeats the mechanical purpose of complete fixation.

The bone graft must not be applied under tension or disintegration will occur with a break in the continuity of the graft. Undoubtedly this is a factor in many of those cases in which there is a fracture of the graft at the original fracture site. I have observed repeatedly such behavior when a graft has been used for conditions other than ununited fractures, for example, in bone grafts of the spine, if the transplant is placed under tension to conform to the kyphos or scoliosis, disintegration usually occurs with separation at the point of greatest stress. Also, a graft

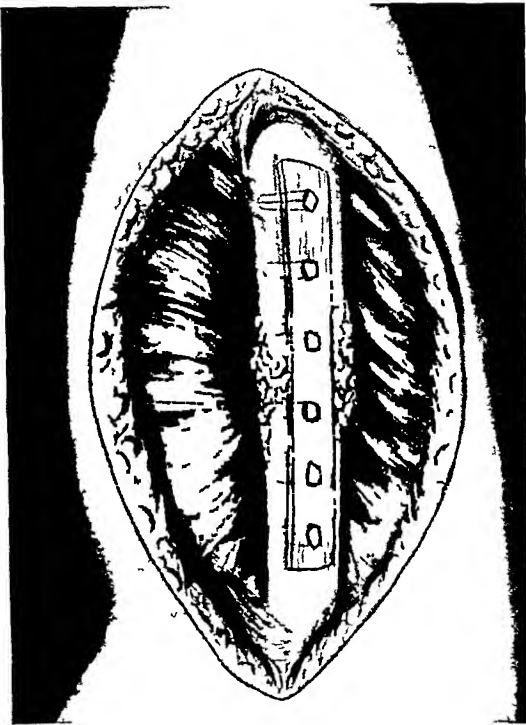


FIG 13.—Bone graft completed. Note small particles of endosteum placed in and adjacent to the fracture site.

may be placed in the spine without tension, but after an increase in the destructive process there may be a gradual increase of the kyphos. In such instances, there will be disintegration at the point of greatest stress, unless there has been sufficient proliferation of the graft itself.

When there has been prolonged drainage from a mild infection, aseptic necrosis or definite disintegration of the graft occurs, followed by substitution. In those in which there is primary union, the graft shows no disintegration but apparently increases in size and becomes a part of the parent bone. Probably the graft may remain alive when the circulation is established early, otherwise the process is one of gradual substitution. The end-results



are the same in both though longer protection is required when the roentgenograms demonstrate absorption

This discussion is based upon facts observed in 50 cases in which operative measures were employed by the technic previously described. There were five females and 44 males, the youngest 16 and the oldest 56, the average being 32. Other facts as to age and location are demonstrated in Table I.

TABLE I

Age		Location	
Below 20	6	Upper third	5
20-30	17	Middle and upper third	5
30-40	14	Middle third	14
40-50	8	Middle and lower third	13
50-60	4	Lower third	12

Of the 50 cases, there were 12 in which radical measures were employed at a time when union may possibly have been secured by conservative measures. Eight of these were at the end of three months and four were under three months. Of the remaining 38, in which undoubtedly a permanent status of nonunion had been reached, from four months to eight years had elapsed since the fracture, the average time being 14.7 months. The roentgenogram revealed the usual well known anatomic types of fractures of the humerus: transverse, short oblique, often with loose fragments, and long oblique or spiral. The latter was found in only one instance and will be discussed later. Nonunion of the humerus in transverse fractures is said to be more frequent but in such a large percentage of our cases there had been previous operations that the original anatomic features could not be determined.

A survey of the roentgenograms of the 38 cases in which an unquestionable status of nonunion had been reached demonstrates three different types: (1) Those in which there is a definite pseudo-arthritis with a shallow cup, usually on the proximal fragment, which is due to the greater vitality as functional use is greater and comminuted fragments fuse to this fragment. In this type, condensation of the bone with obliteration of the marrow cavity by new formed bone is often found. This is an inferior quality of bone comparable to dense scar tissue. (2) Osteoporosis with rapid irregular absorption of lime salts, as evidenced by mottling of the fragments, extends for considerable distance on the shaft from the site of the fracture, as demonstrated by the roentgenogram. This condition is evidently due to a vasomotor phenomenon of the sympathetic nervous system as a reflex instigated by acute trauma. After every fracture there is more or less absorption of the ends of the fragments with increased circulation, probably from the same cause. This phenomenon is also frequently observed after comparatively slight trauma, such as the spraining of an ankle, after operation on joints and in acute infectious processes. In other words, it may be regarded as a natural process of healing which becomes exaggerated to a pathologic degree.

(3) Bone atrophy of disuse is apparent by the paleness of the osseous structure, with diminution of the transverse diameter. The fragments also lose their natural contour and become conical. The marrow is increased at the expense of the cortex, which becomes very thin. At operation excessive fatty infiltration of the marrow is found. Bone atrophy of disuse is exaggerated after the elapse of many months or years, and is due to the loss of physical stimulus of function which maintains the normal size of the bone by cellular activity. It must be distinguished from osteoporosis. In other words, there are two distinct types of osseous atrophy, and possibly two separate physiologic processes.

In the 49 cases in which the massive onlay graft was applied there were three failures, or 93.8 per cent in which solid bony union was procured. The fiftieth case was a long oblique fracture in which fixation was secured without the massive graft, by transfixion of the fragments with autogenous bone nails, resulting in solid union. Of the three in which union could not be induced, two were gunshot fractures with loss in the continuity of the bone. In one of these union was successfully secured after a second operation, so that the final result was excellent. The other gunshot injury was in a stout Negro woman with a four plus Wassermann, and preliminary antisymphilitic treatment was administered. The graft in this case did not secure sufficient fixation due to error in technic. In the third case the graft was most efficiently applied to the bone, but the fragments were not closely approximated, with a space of possibly one-half inch between the fragments. In four cases in which there had been previous injury to the soft parts on the lateral aspect of the arm, the graft was applied to the posterior surface but did not remain sufficiently approximated due to the tendency of posterior bowing, which induced slight separation of the graft from the fragments. The graft should in all cases be applied to the lateral surfaces of the humerus where there is no tendency to displacement.

In the group of 12 cases in which the operation was carried out within four months after the initial fracture, there were no failures. In the 38 cases in which more than four months had elapsed there were three failures, making the percentage of successful results in this group 92.1 per cent, or the entire group of 50 cases, 94 per cent. This is approximately the same percentage as in the previous report of the first 104 cases of ununited fractures of the long bones treated by the onlay graft. The complications are also analogous. There were four postoperative infections, two of which were gunshot fractures, but a firm union was secured in all, despite virulent infection. In the first report there were 17 infections with but one failure to unite. In spite of virulent infection the graft is well tolerated, and in those which sequestrate, fixation is maintained sufficiently long to secure union. Of the 50 cases 12 were compound fractures of which six were gunshot injuries. In eight cases there was a radial nerve paralysis following the primary injury, four of which recovered, two without surgery. There was a definite tourniquet paralysis in four cases, all of which recovered before

normal function of the arm could be permitted. This complication can be avoided by the employment of a pneumatic tourniquet, with which the exact pressure on the arm can be estimated. No amount of care can prevent the injury of nerves by the type of tourniquets in common use, regardless of the precaution used.

The advantages of this procedure are maximum fixation and osteogenesis, which can be routinely secured, and no foreign material is employed. From personal experience, I believe that the employment of endosteum and cavernous bone more efficiently promotes osteogenesis than any other type of graft. By the onlay method no bone is removed from the fragments, but a considerable amount of new bone is added and the normal dimensions and strength are finally increased. Should failure or sequestration, with or without infection, occur, the bone is in a much better condition for future treatment than if a large portion of both fragments is excised in the process of operation.

Due consideration must be given to the physiologic principles of bone regeneration at the time of operation and in the cultivation of osteogenesis by efficient after treatment, until repair and functional restoration of the entire member is complete.

#### REFERENCE

- <sup>1</sup> Campbell, Willis C. The Treatment of Ununited Fractures. *Am Jour Surg*, January, 1923.

# MEMOIRS

## JOSEPH COLT BLOODGOOD

1867-1935

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JOSEPH COLT BLOODGOOD was born in Milwaukee, November 1, 1867. He was descended from a family long prominent in legal circles. He was graduated from the University of Wisconsin with the degree of B S in 1888, and from the University of Pennsylvania with the degree of M D in 1891.



JOSEPH COLT BLOODGOOD, M D

A year later he joined the Staff of the Johns Hopkins Hospital as Assistant Resident Surgeon. From that time on his promotion was steady through all grades, until at his death he was Adjunct Clinical Professor of Surgery in the Johns Hopkins University and Hospital, and Director of the Garvan Research Laboratory. He was also Chief Surgeon to St Agnes' Hospital, and Director of the Cancer Research Fund bearing his name.

While Doctor Bloodgood always retained an active interest in general surgery, he early devoted himself to the study of surgical pathology. In later years, cancer research, more especially its cause, early recognition and prevention, attracted his attention. To this end he was an ardent advocate of publicity in all forms, in order to educate the public to seek medical advice early. As a means of stimulating the profession in the prompt recognition of the disease, he was the chief sponsor for a series of meetings of a group of those especially interested in the study of malignant diseases.

Doctor Bloodgood's contributions to scientific medicine have been more especially along the lines just indicated. But early in the history of the Johns Hopkins hospital, Doctor Bloodgood, as his surgical resident, was of material assistance to Professor Halsted in working out various problems in surgical technic, more especially the development of the use of rubber gloves.

Doctor Bloodgood's scientific enthusiasm was unbounded, his energy tireless. While his methods of thought and action did not always conform entirely to orthodox customs, and hence were at times misunderstood by some, yet to the inner circle of his close friends and chosen associates he was ever an interesting personality, an inspiring teacher, a great surgeon, and a loyal friend.

JOHN M. T. FINNEY

## WILLIAM BRADLEY COLEY

1862-1936

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"Fight on, my men," says Sir Andrew Barton,  
"I am hurt, but I am not slaine ,  
I'll lay mee downe and bleed a-while,  
And then I'll rise and fight againe !"

How often have we who have known Dr. William B. Coley heard him recite the challenging lines of that old Scottish ballad! In looking back over



WILLIAM BRADLEY COLEY, M.D.

his life of three-score and 14 years, one is impressed by the fact that it was indeed a series of hard fought battles—battles for what he believed to be the right, not only in the world of science but in affairs of everyday life. His passing on April 16, 1936, has left us with a sense of loss of great leadership.

For one who has been in close association with Doctor Coley for a period

of so many years as I have, it is difficult if not almost impossible to assume the dispassionate rôle of biographer. However, his achievements in the field of surgery as well as in that of cancer research stand out with such Appalachian clearness that one can point to these lofty peaks with little difficulty.

Doctor Coley believed that heredity played the most important part in a man's life, and it would seem to have had a strong influence on his own. He was born in Westport, Connecticut, on January 12, 1862, of an old New England family. His paternal ancestor was Samuel Coley, one of the forty-nine free planters who settled in Milford in 1639. His maternal ancestor was John Wakeman of Benchley, England, a "freeman of the court of New Haven" (1639) whose son, the Reverend Samuel Wakeman (Harvard, 1655), was one of the first Congregational ministers of Fairfield, Connecticut.

Doctor Coley entered Yale College in the fall of 1880 and was graduated with the degree of Bachelor of Arts in 1884. He taught Latin and Greek at the Bishop Scott Government School in Portland, Oregon, for two years, and then entered the Harvard Medical School in 1886 where he completed the three-year course in two years and was graduated in 1888. As he often remarked, he had taken up the study of medicine and surgery at a most opportune time—when the older surgery with the high mortality from infection was just beginning to be replaced by the newer surgery based on Lister's recognition of the principle of antisepsis. After a strenuous competitive examination, Doctor Coley was appointed an intern on the surgical service of the New York Hospital under Dr. Robert F. Weir and Dr. William T. Bull.

Even at that early date (1888) he showed a keen interest in the subject of sarcoma, and in going over the files of the New York Hospital he came across a case that made a very deep impression upon him. This was a four-times recurrent, apparently inoperable sarcoma of the neck which had apparently entirely disappeared following an attack of facial erysipelas. Doctor Coley was very anxious to learn the end-result—no mention of it was made in the hospital history—so he patiently traced the man from one tenement house to another until he finally located him and learned that he was still in excellent health seven years after the attack of erysipelas. This observation led him in 1891 to start a series of experiments in which he attempted to produce erysipelas in patients suffering from inoperable cancer. Doctor Bull was greatly interested in the work and made it possible for him to treat 12 patients at the New York Cancer Hospital (now the Memorial Hospital) in a special pavilion erected by Mr. Archer M. Huntington. After considerable experimentation, a preparation consisting of the killed cultures of erysipelas combined with the *Bacillus prodigiosus*, was produced which was found to have a marked inhibitory influence upon certain types of malignant tumors, especially sarcoma. This is the preparation known as Coley's toxins, which is in use today. From the very beginning, however, Doctor Coley advocated the toxins only for inoperable sarcoma or as a prophylactic measure.

after operation for bone sarcoma, and not for malignant tumors in general. In 1909, in an address before the Royal Society of Medicine, he gave a detailed description of his method of treatment and the results obtained with it, and in the discussion which followed, Sir Henry Butlin in commenting on the different kinds of so called "cancer cures" stated "With the exception of Doctor Coley's method, scarce a single one has survived." Doctor Coley's faith in the toxins never wavered, and the large number of five year recoveries of inoperable malignant tumors that he was able to report in his address before the Royal College of Surgeons of England in October, 1935, was convincing proof that his faith had been well founded. At that meeting he was elected to honorary fellowship in the Royal College of Surgeons.

Most of Doctor Coley's work with inoperable malignant tumors was carried on at the Memorial Hospital, with which institution he was connected for more than 40 years, and on the Executive Committee of which he was still serving at the time of his death. His interest in this field was so keen and contagious that in 1902, one of his patients, Mrs. C. P. Huntington, influenced more or less by his enthusiasm, donated the sum of \$100,000 for the establishment of the Collis P. Huntington Fund for Cancer Research of the Memorial Hospital—the first cancer research fund ever started in America.

It is rarely that an individual excels in more than one field, but very early in his career Doctor Coley achieved great success in operating for the radical cure of hernia. After reading his report (1897) of a series of 360 antiseptic operations for the radical cure of hernia, in which only one death had occurred and that from ether anesthesia given to a child with weak lungs, Lord Lister, at an important function in London, made the following comment: "An achievement like that is enough to cause gladness in the heart of any man who loves his fellow man. I cannot help remarking that such results could not have been obtained by the mere recognition of the truth of the importance of antiseptic principles. Such success implied that the operator was not only convinced of the truth of those principles, but also that he vigilantly maintained throughout his operations that earnest care which is necessary to prevent those principles being contravened."

Doctor Coley was one of the first in America to adopt the Bassini method of operating for the radical cure of hernia (1890) and in his recent contribution to the Bassini Bicentennial Volume compiled by the surgeons of the University of Padua, Italy, he reiterates his faith in the operation and maintains that it still remains the method of choice in most countries.

After serving as associate and then attending surgeon of the Hospital for Ruptured and Crippled, in 1924 Doctor Coley was appointed Surgeon-in-Chief, which position he held until 1931, when he became Emeritus. In 1908, he was appointed the first surgeon of the New York Central Railroad, serving as Chief Surgeon until January, 1932, when he had reached the retirement age. Another of his professional connections which was a source of great pleasure and satisfaction to him was the Mary McClellan Hospital.



in Cambridge, New York, built by one of his classmates, Mr Edwin McClellan in 1918 Doctor Coley helped to plan the hospital, to obtain an excellent resident staff, and in every way to maintain the highest possible standards for a small hospital in a rural community As Surgeon-in-Chief, he made weekly and later monthly visits, doing much of the major surgery He enjoyed coming in contact with the family doctor of these rural communities and was unstinting in his praise of the latter's sterling qualities

A glance at his bibliography shows him to have been a prolific writer His contributions deal not only with hernia and cancer, but include many essays in other surgical fields

English literature was his greatest hobby, to him the great masterpieces of the world, apart from their solace and charm, were the master instruments of a solid education

In 1897, at the age of 36, Doctor Coley was elected a fellow of the American Surgical Association—the youngest surgeon ever to have been elected In 1902, he became a fellow of the Southern Surgical and Gynecological Association He was a charter member of the American College of Surgeons, in addition he held membership in the New York Surgical, the New York Pathological, the Radiological, and the Harvard Medical societies, as well as in the American Association for Cancer Research, the American Society for the Control of Cancer, and the Association of Surgeons of Great Britain and Ireland (Honorary)

The same rich fulness, which crowned his professional life was apparent in his personal life as well In 1891, he was married to Miss Alice Lancaster, of Newton, Mass She and their two children, Dr Bradley L Coley and Mrs William Boone Nauts, survive him One son, Malcolm, died in his sixth year

We who were associated with Doctor Coley, and who recognized the sterling qualities of his rare personality, realized that there was one quality which surpassed all others, even his boundless optimism, and that was his ever-readiness—in fact, eagerness—to lend a helping hand None appealed to him in vain He loved his fellowmen

In closing, I would repeat the lines uttered at the time he received his degree of Honorary Master of Arts from Harvard University in 1911 (one year after his Alma Mater had conferred the same degree)

“William Bradley Coley, surgeon, medical discoverer, and director of medical research, who learned to cure by surgery ills that had foiled its art, and without surgery others beyond its reach”

CARL G BURDICK

## CARL ARTHUR HEDBLOM

1879-1934

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CARL A. HEDBLOM was born in Boone, Iowa, on March 5, 1879. He died suddenly on June 6, 1934, at Toronto, Canada, while attending a meeting of the American Surgical Association. His death was caused by coronary thrombosis and occurred after an illness of 48 hours. The news of his sudden

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CARL ARTHUR HEDBLOM, M.D.

death came as a great shock to his many colleagues and friends throughout this country and Europe.

Doctor Hedblom was educated at Colorado College, from which he received a degree of B.A. in 1907. In the following year he received a degree of M.A. and in 1921 an honorary D.Sc. from the same college. He was graduated from the Harvard Medical School in 1911 and served his internship and surgical residency under Dr. Maurice Richardson at the Mas-

Massachusetts General Hospital from 1911 to 1913. In 1913 he went to Shanghai, where he was professor of surgery at the Harvard Medical School in China until 1916.

He entered The Mayo Foundation as a fellow in surgery on October 1, 1916. He was head of the section on general and thoracic surgery at The Mayo Clinic from January 1, 1919, to September 15, 1924. He received his degree of Ph.D. in surgery from the University of Minnesota in 1920. He was associate professor of surgery of The Mayo Foundation, Graduate School, University of Minnesota, in charge of the division of thoracic surgery during 1923 and 1924. He was professor of surgery at the University of Wisconsin from September, 1924, to February, 1926, when he accepted the position of professor of surgery at the University of Illinois, which position he occupied at the time of his death.

He was under appointment as Major, Medical Corps, United States Army, and was ordered to report for duty at the time of the armistice which concluded the World War.

Doctor Hedblom was a member of the Society of Clinical Surgery, of the American Surgical Association, of the Western Surgical Association, and of the American Medical Association. He was a member and past president of the American Association for Thoracic Surgery, a fellow of the American College of Surgeons and a member of the Alumni Association of The Mayo Foundation, of Sigma Xi, and of Phi Beta Kappa.

Few surgeons have had a broader training or more extensive experience in surgery than had Doctor Hedblom. In the last 15 years of his life his interest was confined chiefly to thoracic surgery. He entered this field during its early development in this country and obtained an international reputation for his work. It was fortunate for this branch of surgery that a man of his judgment, courage and conservatism became interested in it at an early date, for he was a tireless worker as well as an extensive writer and did much to stabilize the fundamental principles underlying surgery of the thorax. One of his most important contributions to the principles of thoracic surgery was to emphasize the importance, when possible, of dividing extensive operative procedures into stages. Those who were fortunate enough to know Doctor Hedblom will always remember his strong character, his frank friendliness, his cheerful smile and hearty laugh. These characteristics, combined with his inherent honesty and sincerity of purpose, earned for him the greatest admiration and respect of his colleagues and the confidence of his patients. His memory will always be a source of inspiration to progress and achievement.

In 1913, shortly before Doctor Hedblom completed his service in the Massachusetts General Hospital, he married Eleanor Pease, who with three sons and a daughter survive him.

STUART W. HARRINGTON, M.D.

## JONATHAN MAYHEW WAINWRIGHT

1874-1934

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By THE death of Jonathan Mayhew Wainwright on August 3, 1934, the American Surgical Association lost one of its most valued members. He was Vice President of the Association in 1930.



JONATHAN MAYHEW WAINWRIGHT, M.D.

Doctor Wainwright was born February 20, 1874, in Hartford, Connecticut, the son of William Augustus Muhlenberg Wainwright, M.D., whose father was Bishop Jonathan Mayhew Wainwright. His mother was Helena Barker Talcott. He came from old New England stock and was descended from nine colonial governors. He was educated at Hartford High School, and received his B.A. degree at Trinity College, Hartford,

and his M D degree at the College of Physicians and Surgeons, New York, in 1899 Trinity College later conferred upon him an honorary M A degree He served as intern at St Luke's Hospital in New York from 1899 to 1901 and was married immediately upon leaving the hospital to Jessie Bell Hart of Englewood, N J While an intern in the hospital he showed deep interest in his medical work and serious study of the problems thereof In the few hours for recreation which an intern might find in the evening, he occupied himself in the laboratory, cutting and studying pathologic slides which even then formed the nucleus and ground work for the study which he carried on through the rest of his medical career

Immediately upon finishing his internship, although a young man, he became Surgeon-in-Chief at the Moses Taylor Hospital in Scranton, Pa, which position he occupied up to the time of his death He served during the Spanish-American War as Adjutant in the First Connecticut Regiment In the World War, he served overseas successively as Major, Lieutenant Colonel and Colonel in the Medical Corps, and received a citation from General Pershing

Doctor Wainwright was not only an earnest student but a prolific contributor to general surgical literature, as well as many public health problems He was always interested in cancer research, particularly in cancer of the breast, and carried on a correspondence and made a study of not only his own cases, but also of material supplied to him by his surgical colleagues in other cities His slides of complete cross sections of carcinomatous breasts were beautifully prepared and most carefully studied by him He was President of the American Society for Control of Cancer in 1930, also Chairman of the Pennsylvania State Cancer Commission, the first in the field of state work He was director of the Cancer Research Clinic, of Scranton, Pa

In 1930, he made a four-months' trip through Uganda, Kenya and Tanganyika for the purpose of cancer research among the native African tribes In addition, as evidence of his broad interest in other problems of public health, he organized, in 1902, the West Mountain Sanatorium, in Scranton, for the treatment of tuberculosis, and in 1907 he made a study of, and reported on, the Scranton typhoid epidemic which had occurred in the previous year

While Doctor Wainwright's chief interest was always some phase of the cancer problem, and although during his later years most of his surgical contributions pertained to this subject, particularly breast cancer, a list of his surgical contributions covers almost every phase of general surgery

His scientific mind, the concentration of purpose with which he would pursue a problem, his devotion and interest in his professional work, made him an outstanding surgeon, and one of the most valuable men to both the profession and public of his adopted state of Pennsylvania His many friends both in the American Surgical Association and in the profession at

large, as well as of the public generally, have lost one who will be hard to replace

It is indeed an ironical and sad commentary on the progress of the knowledge of the disease to which he had devoted so much of his life's study, that this same disease should have progressed to such a degree in his own case, that the condition was inoperable before a diagnosis could be made

JOHN DOUGLAS

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## THE TOPOGRAPHY OF THE EXTRAHEPATIC BILIARY PASSAGES\*

WITH REFERENCE TO DANGERS OF SURGICAL TECHNIC

A LURJE, M D

Moscow, U S S R

FROM THE INSTITUTE OF OPERATIVE SURGERY IN VORONEZH CHIEF PROF I V GFORGJEVSKY

THE anatomy of variations of the biliary passages has long been studied by many investigators and is elucidated in a number of special articles and manuals. We have no intention of repeating facts already described, but wish to dwell upon some supplementary data obtained as a result of observations made on the extrahepatic biliary passages in a series of 194 cadavers (162 adults and 32 children).

I RELATIONS OF THE GALLBLADDER FUNDUS TO THE LIVER EDGE. In 64 cadavers (33 per cent), the fundus lay 1 to 2 cm above and behind the anterior margin of the liver (Fig 1A). Clinically, this supramarginal type of gallbladder fundus, even when distended, would be difficult to palpate. In 27 cadavers (13.9 per cent), the fundus extended down to the anterior margin of the liver (Fig 1B), and in 103 cadavers (53.1 per cent), it protruded 0.5 to 4 cm below the margin (Fig 1C). Obviously, the third or inframarginal variety is clinically the most readily palpable.

II RELATIONS OF THE POSTERIOR PART OF THE GALLBLADDER AND GALLBLADDER NECK TO THE DUODENOHEPATIC LIGAMENT AND NEIGHBORING STRUCTURES. In 75 cadavers (38.6 per cent), independently of the details of the various forms of the gallbladder, we observed the junction of the posterior part of the gallbladder and cystic duct to be at the posterior end of the gallbladder fossa (Fig 2A). In this group the posterior portion of the gallbladder, sometimes referred to as the infundibulum or Hartman's pouch, did not touch the hepatoduodenal ligament. In three cadavers (1.6 per cent), the infundibulum extended downwards 1 to 3 cm parallel and closely adjacent to the right border of the ligament and the vessels contained therein (Fig 2B). In all of the other cadavers (59.8 per cent), the infundibulum of the variously formed gallbladders overlaid at various distances the upper ends of the structures contained within the hepatoduodenal ligament, thus hiding them from view (Fig 2C).

In most instances, the infundibulum covered that portion of the upper end

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\* The text and illustrations of this article have very kindly been recomposed and edited by Dr Ernest W. Lampe of New York. Submitted for publication April 11, 1936.

of the hepatoduodenal ligament which contained the right branch of the portal vein and the ramifications of the right hepatic artery. Since inflammatory processes are usually most intense at the infundibulum and neck of the gallbladder, it is not uncommon for these parts to become adherent to the above mentioned vessels. The dangers encountered here in attempting blunt separation of the dense type of adhesions are self-evident.

In 25 cadavers (12.9 per cent), the posterior portion of the gallbladder extended so far into the hepatoduodenal ligament as to cover the vessels

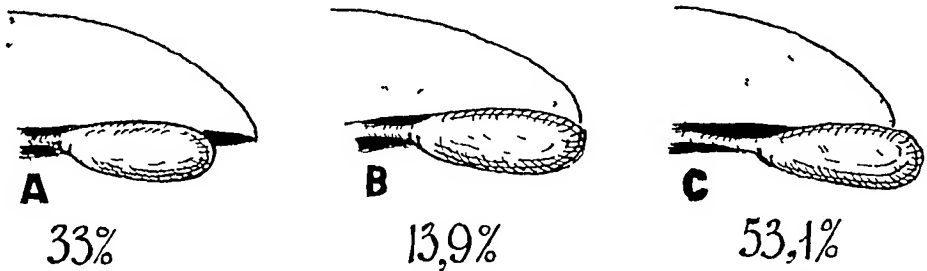


FIG. 1—Shows various positions of the gallbladder fundus to the anterior margin of the liver (A) Supramarginal type (B) Marginal type (C) Inframarginal type

of the hilum. It also covered the upper portion of the hepatic duct. Among these 25 cadavers there were nine with an accessory hepatic duct lying behind the postero-inferior border of the infundibulum of the gallbladder. Following the anterior surface of the right branch of the portal vein (Fig. 3B), the accessory duct extended leftwards from the right extremity of the transverse fissure to join the hepatic duct proper (Fig. 3A). The chances of causing hemorrhage or injury to the biliary passages are quite evident, therefore, when operating in a field presenting the anatomic relations above described.

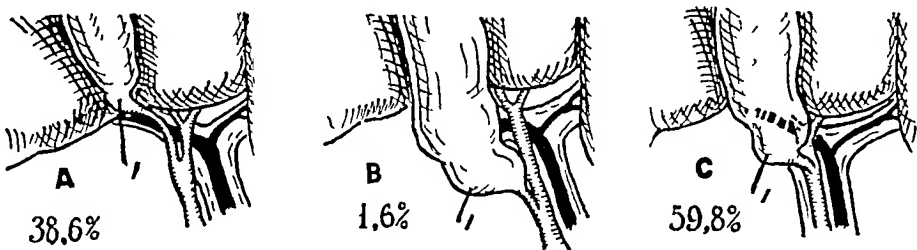


FIG. 2—Shows the relation of the posterior part of the gallbladder to the hepatoduodenal ligament (A) Shows the infundibulum (1) or posterior part of the gallbladder at the posterior end of the gallbladder fossa (B) Shows the infundibulum (1) and a part of the body of the gallbladder extending downwards and parallel to the right border of the hepatoduodenal ligament (C) Shows the infundibulum (1) and a small part of the body overlying the vascular structures in the upper end of the hepatoduodenal ligament

In the cadaver of a man 65 years of age, the whole posterior half of the gallbladder lay upon the anterior surface of the structures of the hepatoduodenal ligament. It covered the cystic duct which arose from the junction of the middle and posterior thirds of the posterior surface of the gallbladder. It also covered almost the entire hepatic duct and a rather uncommon supplementary system of ducts 1 to 1.5 Mm in diameter, which anastomosed with the right hepatic duct (Fig. 4). Operating upon an inflamed gallbladder of this type would be manifestly difficult and dangerous.



**III RELATIONS OF THE CYSTIC DUCT** The cystic duct, en route to its junction with the hepatic, is closely related to the cystic artery, the hepatic artery and its branches, the hepatic duct and the above mentioned accessory

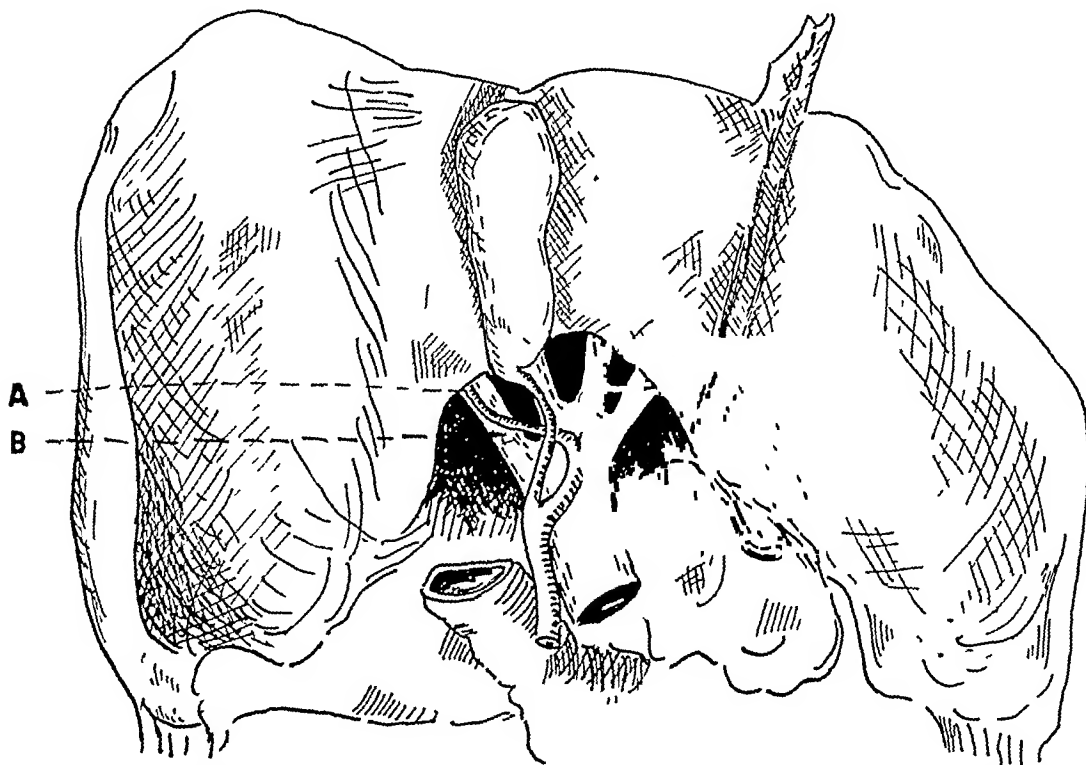


FIG 3—Shows relationship of the accessory hepatic duct (A) to the cystic duct and right branch of the portal vein (B)

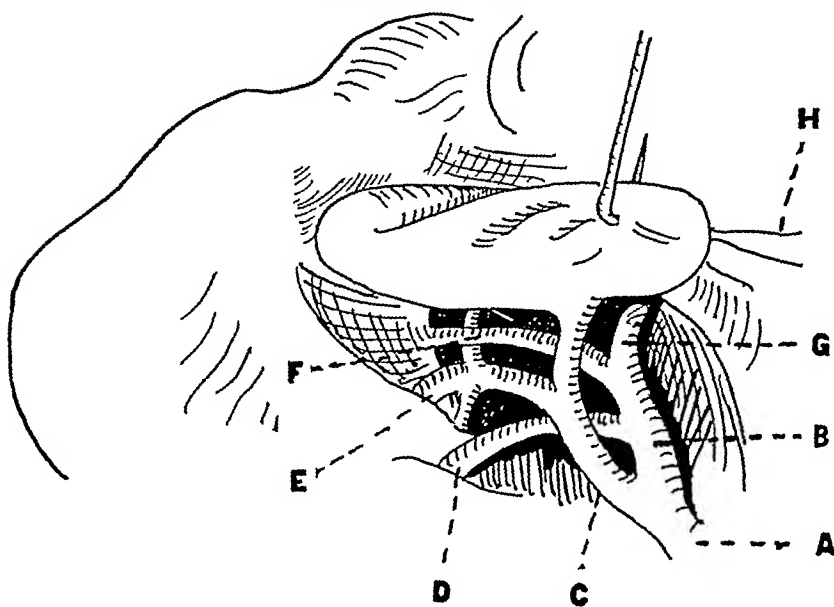
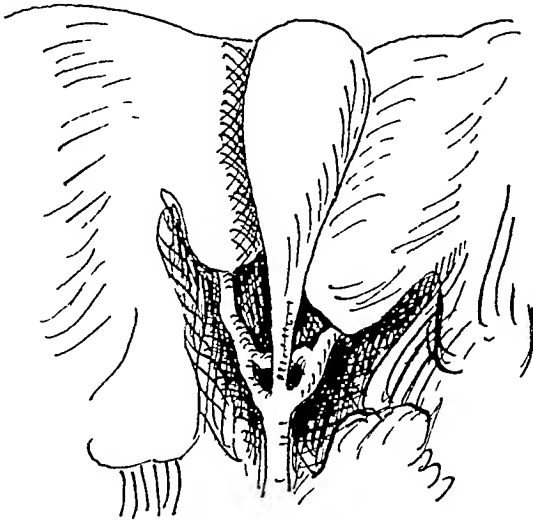


FIG 4—Shows the posterior half of the gallbladder overlying the cystic duct, a part of the hepatic duct and the accessory ducts (A) Common duct (B) Hepatic duct (C) Cystic duct (D) Accessory hepatic duct (E) Another accessory duct with two tributaries joining it (F) Right branch of hepatic duct (G) Left branch of hepatic duct (H) Supplementary ligament between the gallbladder, transverse colon and pylorus

duct In 127 cadavers (65.3 per cent), the cystic duct, usually at its commencement, lay close to the right hepatic artery or its branches, or some distance anterior to them In three cadavers (1.5 per cent), the artery passed

to the right of and behind the duct, in one cadaver it was adjacent to its right side. In 100 cadavers (52 per cent), the right hepatic artery or its branches lay to the right of the gallbladder neck, in the remaining cadavers the artery lay behind the gallbladder without reaching to its right border. In 19 cadavers (10 per cent), the cystic duct was arched, in four of these the lower limb of the arch crossed in front of the hepatic artery.

In these cadavers the gallbladder was displaced backwards, and covered more or less considerable areas of the structures of the hepatoduodenal ligament, and the cystic duct arose below to the left of the right hepatic artery and its branches, forming anatomic variations which should be considered.



**A**

FIG. 5.—Shows the right and left hepatic duct and the cystic duct converging to form the common duct (A).

terior wall of the gallbladder, which might cause confusion.

**IV SUPERNUMERARY BILE DUCTS** In ten observations (52 per cent), the cystic duct crossed closely in front of an accessory hepatic duct—the latter running transversely and downward from right to left (Fig. 3A). This supplementary bile duct was noted 22 times (113 per cent). Three times (16 per cent) the cystic duct entered the point of confluence of the hepatic with the accessory hepatic duct. In one cadaver the cystic duct passed the right and left hepatic ducts and joined them at a common point, so that all three converged to form a single hepatic duct (Fig. 5).

In five dissections (28 per cent), a large and small biliary passage emerged from the right lobe of the liver and entered the cystic duct, and in one of these cadavers the cystic duct received two such biliary passages. These accessory passages may cause postoperative biliary fistulae.

**V RELATIONS OF CYSTIC AND HEPATIC DUCT** Ruge<sup>1</sup> distinguishes three types of relations between the cystic and hepatic ducts. (1) The cystic joins

The relations of the cystic duct and cystic artery offer less interest from the practical point of view since in cholecystectomy this artery always has to be ligated separately.

Usually the cystic artery approaches the upper portion of the duct from the left and then passes on to the gallbladder. However, in 20 cadavers (103 per cent), it followed the duct at a variable distance posteriorly, in 11 cadavers (57 per cent), it left the hepatic artery to the right of the cystic duct, in eight cadavers (412 per cent), it crossed behind the lower portion of the duct and approached the gallbladder from the left, once it crossed in front of the duct, and twice it left the hepatic artery and ran directly up the pos-

the hepatic duct at an acute angle (Fig 6A) (2) The double-barreled type in which the cystic follows the right border of the hepatic duct for some distance before entering it (Fig 6B) (3) The cystic makes a spiral behind the hepatic duct and enters it on its left anterolateral surface (Fig 6C) It might be well to add a fourth type, in which the cystic follows the posterior surface of the hepatic duct for some distance, finally entering it posteriorly (Fig 6D) The first type was found 91 times (46.9 per cent), the second type 60 times (30.9 per cent), the third type 13 times (6.7 per cent), the fourth type 30 times (15.5 per cent)

The cystic duct may join the hepatic within the limits of the hepatoduodenal ligament or behind the first or superior portion of the duodenum The former relation was observed 128 times (66 per cent), the latter 66 times (34 per cent) According to our observations the average length of

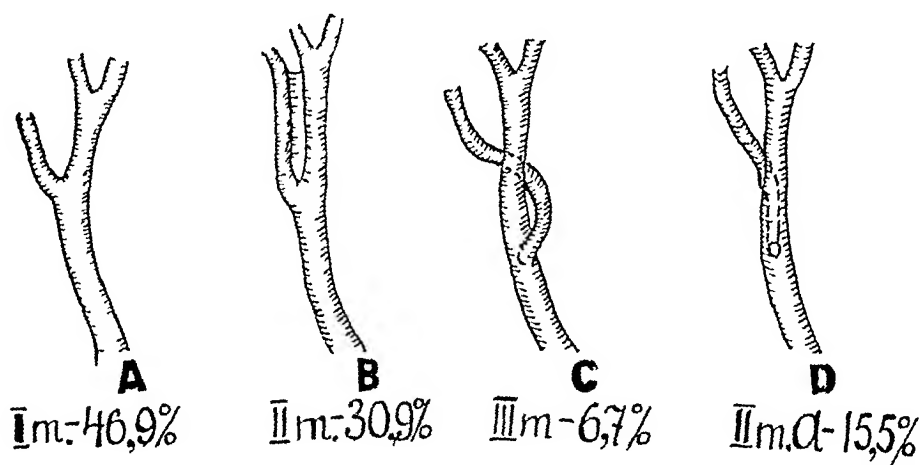


FIG 6—Shows the relations of cystic and hepatic ducts. (A) Cystic duct joins hepatic at an acute angle. (B) Double barreled type of relationship. (C) Cystic duct makes a spiral behind the hepatic duct and enters it on its left anterolateral surface. (D) Cystic duct follows the posterior surface of the hepatic duct, finally entering it posteriorly.

the common bile duct within the limits of the hepatoduodenal ligament is 1.2 cm and ranges from zero to 3.5 cm

VI THE COMMON DUCT If we divide the common duct into three portions (1) that situated within the hepatoduodenal ligament, (2) that lying behind the superior and beginning of the descending parts of the duodenum, and (3) that entering into more or less close relations with the head of the pancreas, we arrive at conclusions which differ from Kehi's,<sup>2</sup> who supposed the three portions to be approximately equal in length

Our data show the average length of the first portion to be 1.2 cm, the second 2.1 cm and the third 2.4 cm The common duct was always found behind the duodenum, but its relation to the head of the pancreas was more variable In most cases, 121 (62.4 per cent), the common duct passed through the substance of the pancreas, was surrounded by it and then entered the posterior internal border of the descending part of the duodenum A terminal portion of the common duct located inside of the head of the pancreas is difficult to expose by either an extra- or a transduodenal route Injury to the pancreas involves considerable hemorrhage and may result

in a pancreatic fistula. Fourteen times (7.2 per cent) the common duct passed at first some distance behind the head of the pancreas and finally, before entering into the duodenum, traversed a small portion of the head of the gland. Twenty times (10.3 per cent) the whole course of the common duct lay behind the pancreas, often in a small groove, and was covered by its fascial capsule. Twenty-seven times the common bile duct passed to the right of the head of the pancreas also being covered by the fascial capsule of the gland, and finally in 12 cadavers (6.2 per cent), the common duct passed in a special bed having the head of the pancreas behind it and

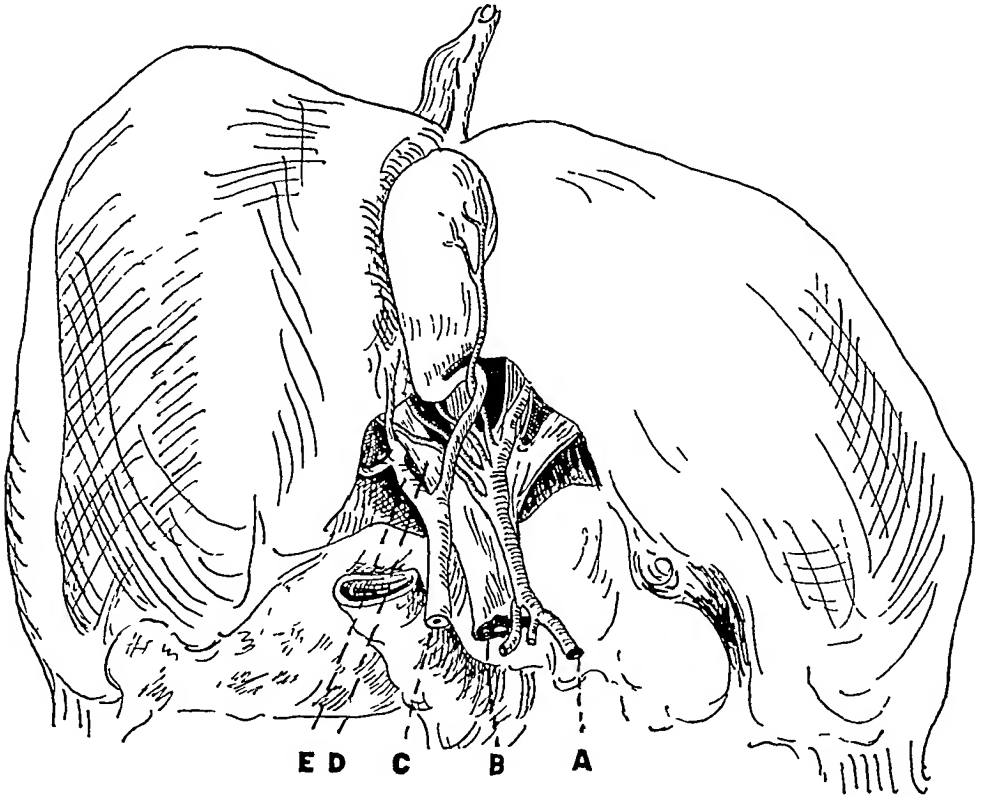


FIG 7—Shows the gallbladder and round ligament embedded in the same fossa—(really buried 1 cm. in the parenchyma of the liver) (A) Hepatic artery (B) Portal vein (C) Common bile duct (D) Right branch of portal vein, with (E) the hepatic duct lying to its right

the duodenum in front, the bed being represented by a groove in the anterior surface of the head of the pancreas. In 95 (48.9 per cent), cadavers the ductus choledochus entered the duodenum quite independently. In 33 cadavers it entered in the immediate vicinity of the duct of Wirsung, in 66 cadavers (34 per cent) before entering the duodenum the common duct on its way through the pancreas joined with the duct of Wirsung to form a common trunk.

The common duct entered the mucosa of the posterior surface of the duodenum at different levels of its descending portion. Thus it entered the upper half of the descending part seven times (3.6 per cent), the middle of the descending part 75 times (38.66 per cent), the lower portion of the descending part 96 times (49.5 per cent), and finally the common duct entered the upper surface of the beginning of the lower horizontal portion

of the duodenum 16 times (82.5 per cent). The initial part of the common duct enters into close topographic relations with the arterial trunks rather often. Thus in 21 cadavers (10.8 per cent) when the right hepatic artery arose from the superior mesenteric, the common duct was located in front of the right hepatic artery, the gastroduodenal artery lay in front of the second or retroduodenal part of the common duct in eight cadavers. In five cadavers the cystic artery arose from the gastroduodenal artery in front of the supraduodenal portion of the common duct, went upwards in front of the common bile duct and then to the left of the cystic duct to the gallbladder.

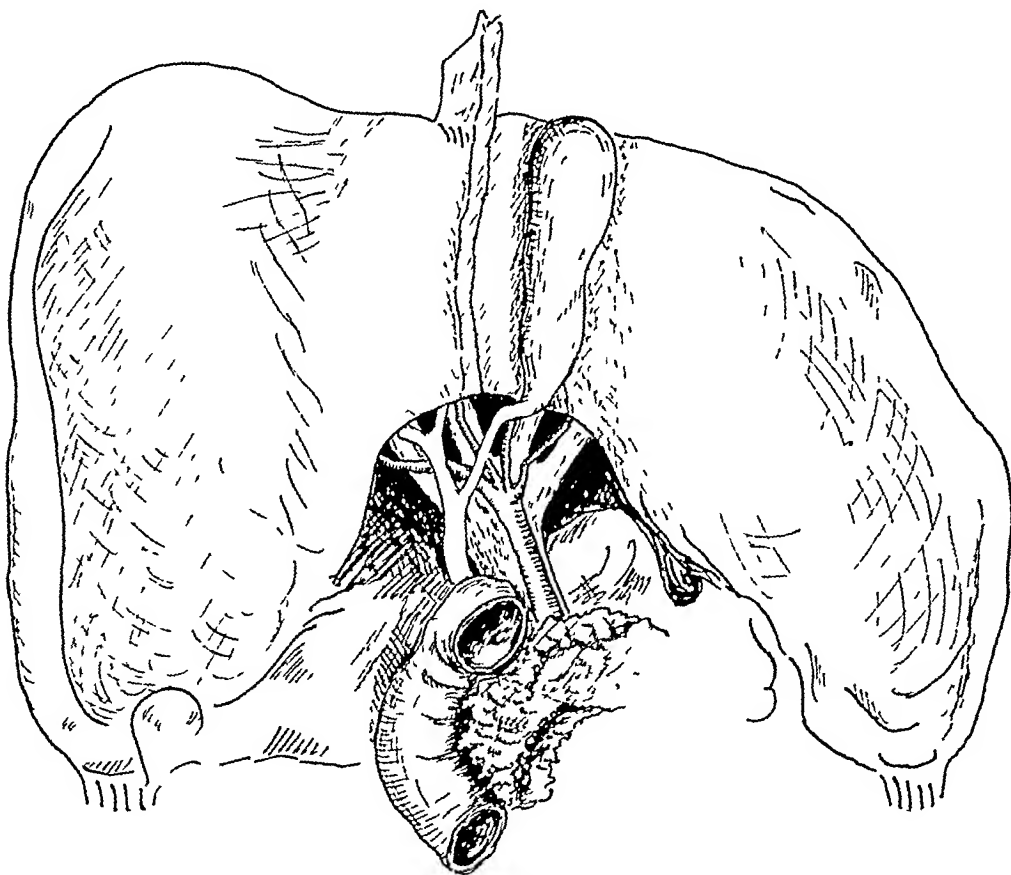


FIG. 8—Shows the reversed position of the gallbladder and round ligament, thus placing the gallbladder to the left of the hepatoduodenal ligament.

VII GALLBLADDERS LYING TO THE LEFT OF THE HEPATODUODENAL LIGAMENT. Finally, we found two cadavers with an anomaly in which the gallbladder lay to the left of the hepatoduodenal ligament. In the cadaver of a man of 27 both longitudinal grooves were absent, and the gallbladder lay on the lower posterior surface of the liver. The round ligament lay in the canal of the liver parenchyma. The cystic duct entered an hepatic duct from the left. This hepatic duct lay to the right of the portal vein, and was formed by the union of the right and left hepatic bile passages. It lay to the right of the branches of the portal vein and passed downwards to the right of the trunk of the portal vein (Fig. 7). In a second cadaver, that of a woman of 30, the right longitudinal groove of the liver was absent from its normal position, so that the liver was subdivided only by the left longitudinal groove into right and left lobes. The round ligament was located in the left longitudinal

groove An oval fusiform gallbladder was suspended from the lower surface of the left edge of the left longitudinal groove by a short mesentery 0.5 cm in length At the posterior end of the lower surface of the left border of the left longitudinal groove, the gallbladder gradually passed into a cystic duct which ran from the left above downwards to the right, lying in front of the left branch of the portal vein and entering the hepatic duct from the left (Fig 8)

In cases of a left-sided gallbladder the surgeon must bear in mind the course of the cystic duct, its close relation to the structures enclosed in the hepatoduodenal ligament which it crosses and also the fact that it approaches the hepatic duct from the left If these peculiarities are taken into account, cholecystectomy may be performed in the usual way by beginning from the anterior end of the gallbladder An attempt to begin the cholecystectomy by dissecting out the cystic duct may cause some difficulty because of its unusual and hidden situation

### CONCLUSIONS

(1) In 59.8 per cent of 194 cadavers dissected, the posterior portion of the gallbladder partly covered the right branch of the portal vein and the branches and trunk of the right hepatic artery, in 12.9 per cent it also covered the beginning of the hepatic duct

(2) The cystic duct crossed in front of an accessory hepatic duct ten times In five cadavers it received supplementary biliary passages from the parenchyma of the liver Dissection of the cystic duct during cholecystectomy will injure such supplementary biliary passages and may lead to a biliary fistula

It is not likely that a surgeon will recognize these small accessory ducts during the course of a cholecystectomy However, should he notice a large accessory duct, the location of which makes its ligation difficult, then it may be wise to remove only the gallbladder, and leave the cystic duct

(3) In 69.6 per cent of this series the common duct passed for some distance through, or was partly surrounded by, the parenchyma of the head of the pancreas before entering the duodenum, an anatomic relationship which might cause hemorrhage from the pancreas in attempting to expose the intrapancreatic portion of the duct

(4) Two cadavers with a left-sided gallbladder and absence of the quadrate lobe of the liver are described

### REFERENCES

- <sup>1</sup> Ruge Arch für klinische Chirurgie, Bd, 87, 47, 1908
- <sup>2</sup> Kehr Chirurgie der Gallenwege u Praxis der Gallenwegechirurgie
- <sup>3</sup> Shachner ANNALS OF SURGERY, 64, 419, 1916
- <sup>4</sup> Wislnewski Arch f klin Chir, Bd 135, 779, 1925
- <sup>5</sup> Haberland, H F O Arch f klin Chir Bd, 139, 319, 1926
- <sup>6</sup> Schumacher Arch f klin Chir, Bd, 160, 499, 1930
- <sup>7</sup> Barlos Arch f klin Chir, Bd, 164, 280, 1931

# TUBERCULOSIS OF THE BREAST

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SIR ASTLEY COOPER described the manifestations of tuberculous disease of the breast as a "scrofulous swelling of the bosom" (1829). This term was descriptive of the advanced type which was brought to the attention of the earlier clinicians and which was often associated with obvious tuberculosis in other organs. Virchow believed the breast was immune to tuberculosis. Lanceaux, in 1860, was the first to establish the diagnosis by microscopic examination. Cuneo, in 1868, isolated the organism from the pus and successfully inoculated an animal with it. The presentation of Dubar's thesis in 1881 furnished a stimulus to the study of this condition as shown by the number of cases reported in the two decades following. Scott,<sup>19</sup> in 1904, reported the largest series of cases (25). In 1930, Morgen<sup>16</sup> collected 439 cases in a comprehensive review of the subject, including six cases of his own.

*Incidence*—The incidence of tuberculosis of the breast may be appreciated by a comparison of more than 450 reported cases with the large number of instances of tuberculosis of other organs and also by the percentage of breast lesions which it constitutes. The number of cases has been expressed in per cent of all breast cases operated upon, 1.04 per cent (Gatewood<sup>13</sup>), all benign lesions, 5 per cent (Bloodgood<sup>3</sup>), all breast carcinoma, 2 per cent (Scott<sup>19</sup>), and all mammary conditions requiring hospitalization, 0.51 per cent (Durante and McCarthy<sup>9</sup>). Elkin,<sup>10</sup> in 1923, stated that the 200 cases reported up to that time constituted about 1 per cent of all breast diseases. The series here reported includes four cases constituting 1.3 per cent of all the malignant breast lesions and 83 per cent of all cases of mammary disease admitted to the Wisconsin General Hospital from 1924 to 1935.

*Classification and Etiology*—The cases are classified as primary or secondary. Where there is no demonstrable lesion other than the one in the breast, the cases are attributed to infection entering through the ducts, skin abrasions, or blood stream. The passage of the infecting organism through abrasions and ducts has been assumed to have occurred in those cases in which history of contact with articles or material harboring tubercle bacilli has preceded the discovery of mammary tuberculosis. Examples of this kind include Ely's<sup>11</sup> case in which the disease was discovered in a breast which had been covered previously by a piece of linen thought to be contaminated with sputum from a patient who had tuberculosis. Fricke<sup>12</sup> reported the case of a woman whose breast contained a tumor which was massaged by her husband. He had pulmonary tuberculosis. Both tuberculosis and carcinoma were found in the breast at operation.

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Hematogenous origin as a source of primary cases has been discredited. It seems unlikely that the tubercle bacillus would enter the blood stream without affecting the tissue through which it passed. Furthermore, it would mean that such an organism, once having gained entrance to the blood stream, would attack the breast in preference to all the other organs, many of which seem to have much less resistance to invasion by this organism. Nagaskima,<sup>17</sup> in 1925, reported 34 cases of disseminated tuberculosis in which no tuberculosis of the breasts was found at autopsy. This work does not substantiate the hematogenous origin of the secondary cases.

The secondary cases are ascribed to invasion by way of lymphatics or contiguous structures. The question of lymphatic origin has resolved itself into a discussion of the presence of involved lymph nodes and whether they were found before or after the disease was discovered in the breast. Barker,<sup>1</sup> in 1926, stated that no more than 5 per cent of the cases were due to extension from axillary or cervical nodes. He noted that half the compiled cases did not have palpable axillary or cervical nodes. He added that many instances of axillary involvement had been preceded by the discovery of the mass in the breast. In Raw's<sup>18</sup> case the successive enlargement of the cervical and axillary lymph nodes on the right and the right breast indicated invasion by a retrograde lymphatic route. Direct extension from contiguous structures has been reported, the primary foci being in the ribs or sternum.

Only the bovine type of organism has been identified in the cases reviewed by Morgen.<sup>16</sup> It would seem that the evidence in this respect is not adequate, as a sufficient number of cases have not been investigated bacteriologically. Barker and Raw have expressed their belief in the predominance of the bovine type.

Heredity does not seem to play any special part in this disease. Trauma, always considered a factor, probably plays a rôle in so far as damaged tissue constitutes an area of lessened resistance. As has been said of carcinoma of the breast, it is quite difficult to evaluate trauma when considering its effect on an organ so obviously exposed to it. The occurrence of bilateral tuberculosis of the breast two weeks after the use of hypodermoclysis needles in those areas is especially significant (Case 3). Cahill's<sup>6</sup> case was discovered approximately two months after the occurrence of a blow on the breast.

The disease attacks a predominant number of females. Only 20 cases in males have been reported by Morgen. One additional case in a male has been reported by Battista<sup>2</sup> in 1931. Many cases have developed during lactation. Cheever's<sup>7</sup> case and one instance in this series are examples. The age group between 20 and 40 includes over half of the cases but this is of no assistance in distinguishing the process from carcinoma.

Many authors believe that mammary tuberculosis is always secondary to a focus elsewhere and that retrograde lymphatic extension is responsible for its occurrence. It is difficult to rule out such a focus. The lack of recurrences following local excision is hard to explain.



The area of diminished resistance is probably the most important etiologic factor as the development of the breast lesion is not usually accompanied by the onset or exacerbation of symptoms of the initial tuberculous focus. Such a view provides for the consideration, as etiologic influences, of those changes which occur in the breast following trauma and during the puerperium and lactation.

*Association with Carcinoma*—The doctrine of Rokitsansky which holds that a tissue is not invaded by carcinoma and tuberculosis simultaneously has long since been disproved. Brodeur<sup>5</sup> reported a series of 22 cases in which tuberculosis and carcinoma were demonstrated in the same tissue. In seven of the cases the two lesions were seen in the same microscopic field. Numerous cases of involvement of the breast in which both lesions were present have been reported and in most instances there is only presumptive proof in regard to the priority of either lesion. Warthin<sup>21</sup> reported three cases of tuberculosis of the breast, two of which were associated with carcinoma. The microscopic sections of tissue from Maker's<sup>15</sup> patient showed tubercle bacilli and carcinoma cells.

*Symptoms and Course*—The lesion is usually unilateral. Simultaneous or successive involvement of both breasts is quite rare. The right breast has been slightly more often invaded but this ratio is without significance. In most instances the discovery of a lump in the breast has been the earliest symptom. Pain has been noted by relatively few patients. The subsequent symptoms and findings depend, to a large extent, on the type and course of the process.

The nodular type tends to remain localized. One or many lumps may be found on physical examination. The confluent type is seen in those cases where coalescence of involved areas has occurred. Such a breast is usually enlarged. On section it shows many caseous areas or abscesses which intercommunicate. This type pursues a more rapid course than does the nodular variety, especially in the lactating breast. Both varieties usually break down and form sinuses if their progress is not interrupted by surgery.

The intraglandular cold abscess is a variation of the confluent type and represents a more effectively walled off process. The sclerosing type is still more rare. It is usually found in older patients and, as the term implies, tends to render the organ small and hard. It quite frequently causes deformity of the breast and is termed by some authors the pseudoneoplastic form. Morgen points out that this type has been compared to fibroid phthisis because of the age group in which the two lesions are most frequently found. Sinuses rarely occur in this type.

The overlying skin may resemble the "orange peel" change seen in carcinoma. It exhibits, first, the edema and discoloration of lymph and venous stasis. Later, as sinus formation is imminent, redness and heat are added to the picture which is then more characteristic of inflammation.

Early invasion of the axillary nodes is quite characteristic of the disease and was found in 236 of the 439 cases reviewed by Morgen. Some of

the remaining cases in the series may have had glandular extension but, as frequently occurs in carcinoma of the breast, it may have been impossible to demonstrate clinically

*Diagnosis*—Moigen says "The clinical findings are not always sufficient to aid the physician to make a correct diagnosis. A lump in the breast of long duration not associated with pain or retraction of the nipple but associated with glandular enlargement is very suggestive. If to this is added the presence of a fistula discharging a gritty caseous material one can fairly safely make the diagnosis of breast tuberculosis."

The diagnosis is usually easily made from the microscopic picture. The presence of caseation, epithelioid hyperplasia, and the typical Langhans' giant cell with peripherally placed nuclei are generally sufficient to identify the process. The organisms are recovered from the lesions with difficulty.



FIG 1—Photomicrograph showing breast tissue in which there is a marked inflammatory reaction. The most characteristic feature is the endothelial hyperplasia and tubercle formation. Some of these tubercles contain Langhans' giant cells. Elsewhere, there is infiltration by lymphocytes and plasma cells. There is caseation with abscess formation, the wall of the abscess cavity being lined by large epithelioid cells.

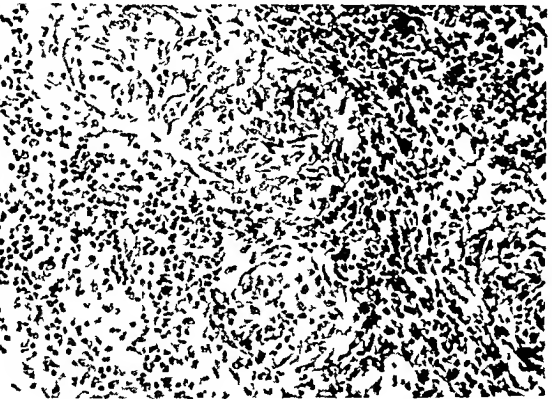


FIG 2—Photomicrograph showing no breast acini, but a chronic inflammatory reaction which is characterized by lymphocytic infiltration, epithelioid tubercles and giant cells. Some of the giant cells are of Langhans' type but the majority resemble foreign body giant cells. No frank caseation is apparent.

The correct diagnosis was made in one of the four cases in this series (Case 2). The other cases were diagnosed chronic mastitis, carcinoma, and adenofibroma.

*Treatment*—The treatment has been surgical in most cases but the extent of interference has varied. Scudder<sup>20</sup> reviewed the treatment used up to the time he wrote his article (1898) and found it included the following: (1) curettage of the sinuses, (2) cauterization of the sinuses, (3) excision of the tumor, (4) excision of the tumor and the breast, (5) excision of the axillary nodes, and finally (6) the excision of both the axillary nodes and the breast. In the 63 cases analyzed by Barker only 14 of them had surgery which included the removal of axillary nodes.

The treatment at the present time consists of removing the local process. If multiple sinuses are present and there is invasion of the axillary nodes, a radical mastectomy may be indicated. Hartwell's<sup>14</sup> case was treated by local excision, and the enlarged axillary node subsided spontaneously.

The general tendency to investigate surgically any lump in the breast will cause tuberculosis to be discovered in its early stages. This will permit more conservative operations and increase the number of cases in which local excision will suffice.

*Prognosis*—One of Gatewood's<sup>13</sup> cases which was operated upon in 1909 returned in 1912 with a small abscess in the same breast from which the tubercle bacillus was isolated. A diagnosis of tuberculosis had been made in 1909 from microscopic section. In Moigen's review of the subject there were 11 cases in which a history of previous breast abscess was elicited. There seemed to be no indication that the tuberculous processes subsequently discovered represented recurrences.

Deaver,<sup>8</sup> in 1914, reviewed the results listed in the cases up to that time, and tabulated them as follows:

Results not listed	41 cases
Uneventful recovery	13 cases
Not operated upon	1 case
Healed by primary intention	1 case
Discharged in good condition	3 cases
Fistula remained	2 cases*

\* One followed "a simple mastectomy and cleaning of the axilla," and the other followed simple excision.

The remaining 13 cases were alive and well "several months" to 13 years later. Biaendle's<sup>4</sup> follow up notes on 15 cases showed that two died several years later from tuberculosis but without evidence of local recurrence. Of the remaining 13 none had shown local recurrence, or evidence of the disease elsewhere four, eight, and 11 years later. Of the 13 living patients, ten were between 40 and 50 years of age at the time of the report (1906).

## CASE REPORTS

**Case 1**—Hospital No 57987 Surgical Pathology No 12096 J Z, a white female age 41, entered the Wisconsin General Hospital January 5, 1932. She had first noticed a painful and tender lump in the left breast in the spring of 1931 while nursing her tenth child. The pain, which was fairly constant, became more marked during menstrual periods, and necessitated weaning the child. In November, 1931, the breast opened spontaneously and pus drained through the opening overlying the mass in the outer quadrant of the left breast for about a month. The drainage subsided and the breast healed about three weeks before the patient entered the hospital. There was no history of trauma, tuberculosis, or of any previous breast involvement. There were no pulmonary symptoms.

Physical examination demonstrated the presence of adenopathy of the anterior cervical nodes and an irregular discrete elastic mass in the outer quadrant of the left breast. The overlying skin was discolored and fixed. Moderate retraction of the nipple was seen. No axillary adenopathy was present. The liver edge was palpable and slight edema of the extremities was noted. Roentgenography of the chest revealed a slight peribronchitis. The urinalysis, complete blood count, blood chemistry and serology determinations showed normal findings. A diagnosis of chronic mastitis was made. On January 8, 1932, local excision of the mass in the outer quadrant of the breast was performed. The central portion of the mass showed an abscess cavity and microscopically both acute and chronic inflammation was seen, the latter process predominating. Tubercles and giant cells were

plentiful in these sections. A slight amount of drainage was present when the patient left the hospital January 23, 1932.

**Case 2**—Hospital No 55572. Surgical Pathology Nos 14263, 14460. M. H., a white female, age 41, had previously been a patient in the Wisconsin General Hospital during July and August, 1931, at which time a diagnosis of bilateral infected hydronephrosis was made. Colon bacilli were demonstrated by culture in the urine obtained from each ureter. Appropriate treatment was given and the infection subsided. The breasts were found to be normal at that time, but the nipples were tender. The lungs were normal as determined by physical examination.

On readmission, December 5, 1932, the patient complained of a tumor in her left breast, first noticed in June, 1932. The mass was about eight centimeters in diameter. Itching of the left breast had been experienced occasionally. On December 2, 1932, the overlying skin, which had become hot and red, broke through, releasing about a teacupful of yellow pus. The past history revealed attacks of redness and heat in the left breast which had been treated successfully with moist heat. There was no history of trauma to the breast. The patient nursed two of her children, the periods of lactation being uneventful. No difficulty was encountered in the right breast. History of "winter colds" and a mildly productive cough was elicited. No tuberculosis in collaterals or forebears was reported. In March, 1932, a mass in the right side of the neck was incised and had continued to drain. The marital history revealed five pregnancies and three miscarriages.

Physical examination revealed a poorly nourished patient. The jaws were edentulous, the tonsils moderately enlarged. There was a soft tumor mass and an adjacent draining sinus in the right side of the neck. No axillary adenopathy was present. The left breast contained many rope like masses. An ulcer measuring 2 by 3 cm. was present in the lower outer quadrant.

Complete blood count and blood chemistry were within normal limits. Urinalysis and blood Wassermann were negative. No tubercle bacilli were found in the sputum. Smears and cultures of the wound in the left breast were negative for tubercle bacilli. Roentgenographic examination of the chest showed an irregular fibrous increase of the right hilum and a single calcified deposit in the left apex. A diagnosis of mammary tuberculosis was made.

On December 12, 1932, a simple mastectomy was performed. One sinus was found to extend down to the pectoralis fascia. On January 14, 1933, the sinus tract in the right side of the neck was excised. The tissue removed at each operation showed caseation and giant cell formation and was diagnosed tuberculosis. Healing in both areas was satisfactory. The patient was discharged January 21, 1933. On readmission, April 5, 1933, for care of congenital cataracts, the neck and breast wounds were well healed. The sputum was negative. Roentgenogram of the chest showed no significant change. No signs of tuberculous activity were found clinically.

**Case 3**—Hospital No 56749. Surgical Pathology Nos 17674, 17751. I. S., a white female, age 36, was readmitted to the Wisconsin General Hospital April 28, 1934. On February 4, 1934, she had had a cholecystostomy elsewhere and following the operation hypodermochysis had been used, the needles having been inserted at the lateral borders of the breasts. These areas remained sore. Two weeks later (February 18, 1934), she noticed a lump in the outer quadrant of the right breast. Some sharp pain had been noticed in this area. The mass had not increased in size since its discovery. Inventory by systems was essentially negative. No history of tuberculosis in forebears or collaterals. The patient had five children and one miscarriage. In 1918 both breasts had multiple abscesses which had healed and caused no further trouble. In 1929, an eczema-toid lesion was present about both nipples but it subsided with simple treatment in two weeks. There had been no discharge from the nipples.

The submammary lymph nodes were palpable. A mass, 3.5 cm. in diameter was found in the outer quadrant of the right breast. It was discrete and attached to the

overlying skin, a portion of which was discolored and edematous over an area about 1 cm in diameter. No enlargement of the axillary nodes on either side was demonstrable. A similar mass was found in the left breast but with no change in the overlying skin.

The uranalysis, blood count, blood chemistry, and serology did not demonstrate any abnormalities. Roentgenographic examination of the chest revealed a caseocalcareous lymphadenitis of the right hilum. A diagnosis of carcinoma of the breast was made. At operation, May 5, 1934, a local excision of the mass was performed. Green pus was encountered and the area was drained. Ten days later the mass in the left breast was removed and green pus was released.

Microscopically the tissue from each breast showed epithelioid hyperplasia, caseation and giant cell formation. Smears and cultures from the wound in the right breast six days after operation showed Staphylococci. The tissue and a swab of the pus from the left breast were cultured but the tubercle bacillus was not recovered. Intradermal tuberculin test was positive in 48 hours. Both breast wounds healed well and the patient was discharged June 8, 1934.

**Case 4**—Hospital No 58302. Surgical Pathology No 18693. E. I., a white female, age 34, was first admitted to the Wisconsin General Hospital in January, 1932, at which time a ventral hernia which had occurred following a laparotomy in 1929 was repaired. There were no respiratory symptoms, the lungs were normal, and no masses or tenderness were noted in either breast. There was no history of tuberculosis in collaterals or forebears. On readmission, August 21, 1934, the patient complained of a tumor in her left breast which was first noticed in March, 1934, and had gradually increased in size. No axillary adenopathy was demonstrable. Intermittent pain had been experienced but it was not definitely associated with menstrual periods. The patient could remember no trauma to the breast and no discharge from the nipple. Recurrence of the ventral hernia was noted. The patient had been married 13 years, had been pregnant three times, and had had one miscarriage.

Uranalysis and blood Wassermann were negative. The complete blood count and blood chemistry were within normal limits. A diagnosis of adenofibroma was made. On August 24, 1934, local excision of the mass was performed. It proved to be an abscess filled with green pus. The wound was drained. Healing was satisfactory. Microscopic section showed numerous hyperplastic tubercles with giant cells. The diagnosis was tuberculosis. Smear, culture, and guinea pig inoculation failed to demonstrate tubercle bacilli. The breast wound healed satisfactorily and the patient was discharged November 10, 1934.

#### CONCLUSIONS

(1) Four cases of tuberculosis of the breast are presented. All were in females, one was bilateral, and two were primary. The diagnosis in each case was proven by microscopic section. One case was diagnosed correctly before operation.

(2) Mammary tuberculosis is not as rare as it is ordinarily thought to be. It occurs in many individuals who show no other tuberculous lesion. It is not often diagnosed before operation unless sinuses are present or unless the patient is known to have tuberculosis of some other organ.

(3) Since the development of the breast lesion is not usually accompanied by the onset or exacerbation of symptoms of a tuberculous process elsewhere in the body, the area of lessened resistance is the most important etiologic factor.

(4) Recurrences after operation are rare.

## REFERENCES

- <sup>1</sup> Barker, H B Tuberculosis of the Mammary Gland Arch Surg, 13, 435-444, September, 1926
- <sup>2</sup> Battista, A Tuberculoma Primitive Dells Mammella Maschile Folia Med, 17, 622-640, May, 1931
- <sup>3</sup> Bloodgood, Kelly H A, and Noble, C P Gynecology and Abdominal Surgery, 2, 211 W B Saunders, 1908
- <sup>4</sup> Braendle E Ueber die Tuberkulose der Brustdruse Beitr z klin Chir, 50, 215-228, 1906
- <sup>5</sup> Broders, A C Tuberculosis Associated with Malignant Neoplasia J A M A, 77, 390-394, February, 1919
- <sup>6</sup> Cahill, J A Tuberculosis of the Mammary Gland Surg, Gynec, and Obstet, 40, 227-229, February, 1925
- <sup>7</sup> Cheever, D Tuberculosis of the Mammary Gland Surg Clin N Amer, 1, 919-926, June, 1921
- <sup>8</sup> Deaver, J B Tuberculosis of the Breast Am J Med Sci, 147, 157-185, February, 1914
- <sup>9</sup> Durante, L, and McCarthy Tuberculosis of the Breast ANNALS OF SURGERY, 63, 668-671, June, 1916
- <sup>10</sup> Elkin, D C Tuberculosis of the Breast ANNALS OF SURGERY, 77, 661-667, June, 1923
- <sup>11</sup> Ely, J S Tuberculosis of the Breast Proc New York Path Soc, 81, 1890
- <sup>12</sup> Fricke Ein Fall von Karzinom und Tuberkulose der Mamma Beitr z klin d Tuberk, Wurz, 8, 309-316, 1907
- <sup>13</sup> Gatewood Tuberculosis of the Mammary Gland J A M A, 67, 1660-1663, December 2, 1916
- <sup>14</sup> Hartwell, J A Tuberculosis of the Breast ANNALS OF SURGERY, 58, 593-605, March, 1913
- <sup>15</sup> Maker, L E Carcinoma of the Breast and Tubercular Abscess J A M A, 31, 1581, December 31, 1898
- <sup>16</sup> Morgen, M Tuberculosis of the Breast Surg, Gynec, and Obstet, 53, 593-605, November, 1931
- <sup>17</sup> Nagaskima Virchows Archiv fur Pathologische Anat und Physiologie und fur Klin Med, 254, 184-202, 1925
- <sup>18</sup> Raw, N Tuberculosis of the Breast Brit Med Jour, 1, 657-658, April 12, 1924
- <sup>19</sup> Scott, S R St Barth Hosp Rep, 40, 97, 1904
- <sup>20</sup> Scudder C A Case of Tuberculosis of the Breast Am Jour Med Sci, 116, 75-85, July, 1898
- <sup>21</sup> Warthin, A C Carcinoma and Tuberculosis Am Jour Med Sci, 118, 25-35, July, 1899

# MEDIASTINAL TUMOR CAUSED BY HODGKIN'S DISEASE\*

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LYMPHADENOMA (Hodgkin's disease) apparently is an infectious granuloma with a characteristic histologic picture and a typical clinical course. The clinical aspect is usually that of a slow, painless, progressive enlargement of the lymphatic nodes of the body, beginning with those of the cervical chain. Later, other organs, especially the liver and spleen, are involved. Generally the disease is considered as incurable, although improvement for many years may follow treatment.

In the typical case the cervical nodes are the ones first affected. In the statistics compiled by Baldrige and Aive (1930) the mediastinal nodes were reported as primarily enlarged six times in a total of 136 cases. Wessler and Green (1920) and others distinguish a mediastinal tumor caused by Hodgkin's disease. Ewing concludes that mediastinal Hodgkin's disease is a thymic tumor and different from the ordinary Hodgkin's disease.

Ziegler, in his monograph, describes the mediastinal type of Hodgkin's disease in detail and states that it may be impossible to determine whether the processes arise in the lymph nodes or in the thymus, since at the stage at which death occurs there is no evidence of thymic origin. He believes that it may be assumed that the granulomatous process has its origin in the peritracheal lymph nodes and that larger single granulomatous masses are secondarily formed in the anterior mediastinum, the loose tissue of which favors the formation of large single masses. Apparently he questions the occurrence of purely single Hodgkin's tumors in the anterior mediastinum and suggests that the primary seat may be in the lymphatic tissue of a persistent thymus.

Hodgkin's disease is considered as being sensitive to radiation and thymic new growths as being radioresistant, and hence it would seem that the reaction of mediastinal tumors to a test dose of radiation would be of value in their differential diagnosis. Haagensohn believes this to be true. It is not true in the case herein reported because this patient was thoroughly treated by radiation without improvement and yet the histologic picture is precisely that of Hodgkin's disease. We must assume, therefore, that it represented an unusual case of radioresistant Hodgkin's disease or was of thymic origin indistinguishable from Hodgkin's. There is no evidence of thymic tissue in the microscopic sections.

**Case Report**—No 713 1936 Female, age 17, was admitted to the Misericordia Hospital August 17, 1935, complaining chiefly of dyspnea on exertion. Her history

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dated back to February, 1933, at which time she was given a tuberculin test at school which showed a slight reaction (plus one) A roentgenogram of the chest showed a shadow on the left side that was considered as being either a persistent thymus, a mass of tuberculous lymph nodes, or possibly a sarcoma Six months prior to this time, however, she complained of a dry cough which lasted the entire summer of 1932 Shortly after the detection of the mediastinal shadow the patient was put to bed and remained there for a period of one year During this period no abnormal temperature, cough, pressure symptoms or loss of weight was noted, although the patient developed a general physical weakness which has continued

In September, 1933, she was given a series of roentgen therapy treatments, but, if anything, there was enlargement of the shadow rather than a diminution In March, 1934, she was again examined and at that time the diagnosis was made of a benign tumor of the mediastinum or an enlarged thymus gland The patient was allowed out of bed to lead a normal life but without strenuous exercise In September, 1934, she was admitted to the Hospital of the University of Pennsylvania Roentgenologic examination by Doctor Pendergrass showed a shadow inseparable from that of the heart, and he believed the case was one of benign tumor of the anterior mediastinum, suggesting the possibilities of a cyst springing from the pericardium, a thymoma or a lipoma He noted that the mass was considerably larger than was noted in the roentgenograms taken a year previously She was seen by Doctor Wolferth, who advised a conservative policy unless there was evidence of bronchial compression She was bronchoscoped by Doctor Tucker, who found that there was an oval appearance of the lumen of the left main bronchus but no indication of localized compression or infiltration of the left bronchial stem He also believed that unless the condition caused symptoms from pressure or inflammatory exudates, it might be better to keep the patient under observation This was done, but in the summer of 1935 it was felt that the shadow was getting larger, and accordingly she was referred for operation

At the time of her admission, as has been noted, there were no symptoms except weakness and dyspnea on exertion There was an area of dullness corresponding to the mass seen in the roentgenograms, with evidence of pulsation We agreed with the earlier report of Doctor Wolferth that this was a transmitted pulsation and not that due to aneurysm

*Roentgenologic Examination*—By Doctor Bertin Chest examination in the P A view shows an enormous enlargement of the cardiac silhouette and depicts an abnormal projection smoother in contour from the left border of the heart shadow The right border of the cardiac shadow is displaced to the right The lateral view shows this entire huge shadow overlying the heart shadow anteriorly The posterior border of the shadow is slightly more prominent than normal and impinges only very slightly into the mediastinal space It is therefore likely that this mass does not originate in the posterior mediastinum Its nature and exact extent cannot be demonstrated from the film alone There is a sharp angulation in the middle of the right diaphragm which is characteristic of pleural adhesions There are numerous small calcified bronchial lymph nodes on both sides with no evidence of active disease in either lung The left base is slightly more dense than the remaining portion of the lung area, possibly due to compression resulting from the enlargement in the anterior chest

Fluoroscopically we were able, however, by rotation in various positions, to determine the cardiac silhouette apart from this general mass to the left of the cardiac border During forced inspiration the apex of the heart could be clearly visualized and the cardiac shadow showed no evidence of enlargement The mass showed general wave like pulsations corresponding with the heart beat but decidedly less marked, giving the impression of a cyst like mass, situated immediately in front and to the left of the heart shadow

The impression finally arrived at was that she had either a dermoid cyst or a benign tumor such as a fibroma or lipoma It is interesting to note that a cousin died some



years previously from a condition suggestive of a large sarcoma or tumor in the mediastinum. No operation was performed.

Except for being thin and somewhat weak the patient was in good general condition. Hemoglobin 65 per cent. R B C 3,060,000. There was no leukocytosis. A Wassermann test was not made. Operation was performed August 20, 1935, under gas-ether anesthesia with provision for positive pressure in the mask. Arrangements were made for endotracheal anesthesia if such was deemed necessary. As a matter of fact there was no trouble with the anesthetic.

*Operation*—An incision was made, similar to that described by Graham, and extended transversely over the level of the fourth rib three inches on either side of the sternum. As the exact relation of the tumor to the heart, its adhesion and its location were somewhat uncertain, it was thought advisable to begin on the right side so as to approach it from near the median line, and work across. As in Graham's technic, the sternum was to be divided transversely. Accordingly the third and fourth ribs were exposed and a small portion of the cartilages removed on either side. With finger exploration across the posterior aspect of the sternum it was found that the tumor was anterior to the heart in the anterior mediastinum, that it was solid and not cystic, and was encapsulated. The fourth costal cartilage on the left side was then removed for a short distance and the sternum divided with a Gigli saw. Sometime during this procedure the right pleura was nicked but as the lung was easily inflated and the pleura readily closed with catgut sutures, it was thought that no harm had resulted, although later a moderate degree of pneumothorax was noted. The divided sternum was then retracted and the tumor mass, measuring 6 by 4 by 2 inches in size, was gradually dissected from the surrounding structures. It was impossible to do this without a wide opening of the left pleura. A small pedicle, perhaps one-eighth of an inch in diameter, tapering upwards toward the neck, was divided. It seemed to carry a blood supply. The tumor mass was then drawn from the wound and the pleural cavity on the left side sutured as carefully as possible, although it was realized that this was imperfectly accomplished owing to its thinness. The sternum was drilled and a doubling suture of number two chromic catgut introduced to draw it together in a mattress fashion. Owing to the fact that a good deal of oozing was present in the mediastinum and fearful that this might seep into the pleural cavity, it was thought advisable to introduce a cigarette drain for a few days. It was thought that the pleura would become adherent to the tract and obliterate it. In this we were in error. The muscles, fascia and skin were brought together and the patient given 500 cc of citrated blood intravenously. She left the table in good condition.

As things turned out it would have been satisfactory to have approached this tumor entirely from the left side, but the roentgenograms were somewhat misleading in making us believe that it was under the sternum, extending to the left, when actually it barely touched the sternum on the left side.

Following the operation the patient had a stormy first 48 hours, probably due to the considerable pneumothorax remaining on the left side and the moderate pneumothorax on the right side, thus causing a limitation of vital capacity. She was kept in an oxygen tent for four days and was able to breathe easily without dyspnea after removal from the tent. The cigarette drain was removed. However, dyspnea always was pronounced and the patient seemed to have difficulty in moving the thoracic cage during and after respiration. This produced, I think, a sawing effect on the catgut because in about ten days' time the lower part of the sternum sank somewhat and this seriously interfered with the motions of the lower part of the chest. This was disastrous in another way because it kept the wound opened at the site of drainage and we soon saw that this communicated with the left pleural cavity, keeping up the pneumothorax in spite of every effort made to plug this hole and remove the air in the left chest by aspiration. Shortly afterwards she developed a pleural effusion on the right side which was aspirated several times and

still later she developed a purulent effusion in the left cavity although at first no organisms were found to culture but later a *Staphylococcus albus* was discovered

On September 19, 1935, under local anesthesia, an interrib drainage was introduced, attached to a continuous aspirator, following which there was a considerable increase in the expansion of the left lung Early in October the right side appeared to show but little fluid and only a small degree of pneumothorax Collapse of the left lung, however, was total At this time I anticipated that the patient might make a difficult but an ultimate recovery It should be mentioned that several transfusions were given during this time



FIG 1—Appearance of tumor on bisection

However, on October 17, 1935, she developed a cold, an acute bronchitis and apparently a bronchial pneumonia, which so violently interfered with the respiratory function that nothing availed and she died October 19, 1935

*Pathologic Examination*—By Doctor Camero The specimen consists of a well circumscribed well encapsulated, ovoid, tumor mass measuring 15 by 12 by 10 cm The surface is smooth The cut surface is uniformly white, firm around the periphery and softer in the central portion The mass is not very vascular (Fig 1)

*Microscopic Examination* of several sections made from the tumor mass shows the tissue to be undoubtedly lymphoid in origin Lymph node architecture is almost completely destroyed though there persist small follicles and an hyperplastic reticulum The chief histologic features are (1) Irregular abundant fibrosis, some of which has undergone a sclerosing process (2) Marked variation in the type of cells The following types of cells are predominant, lymphocytes, eosinophils, neutrophils, fibroblasts, mono-

cytes, other mononuclear cells and typical Dorothy Reed giant cells (3) Necrosis. Scattered areas show necrosis (Figs 2 and 3). The histologic picture here seen and above described is typically that of Hodgkin's disease. The sections were shown to Dr Herbert Fox, who confirmed the diagnosis.

An autopsy showed nothing that was not known prior to death, the principal features of which were an atelectasis of the left lung, a bronchial pneumonia with partial atelectasis of the right lung and the remnants of a left empyema. There was an hyperplasia of the lymph nodes in the mediastinum but no evidence of Hodgkin's disease in them. There was no evidence of the nodules of Hodgkin's disease in the spleen, liver, pancreas or kidneys. The heart and pericardium were normal. The patient apparently died from the bronchial pneumonia following the greatly lessened air capacity of the two lungs.

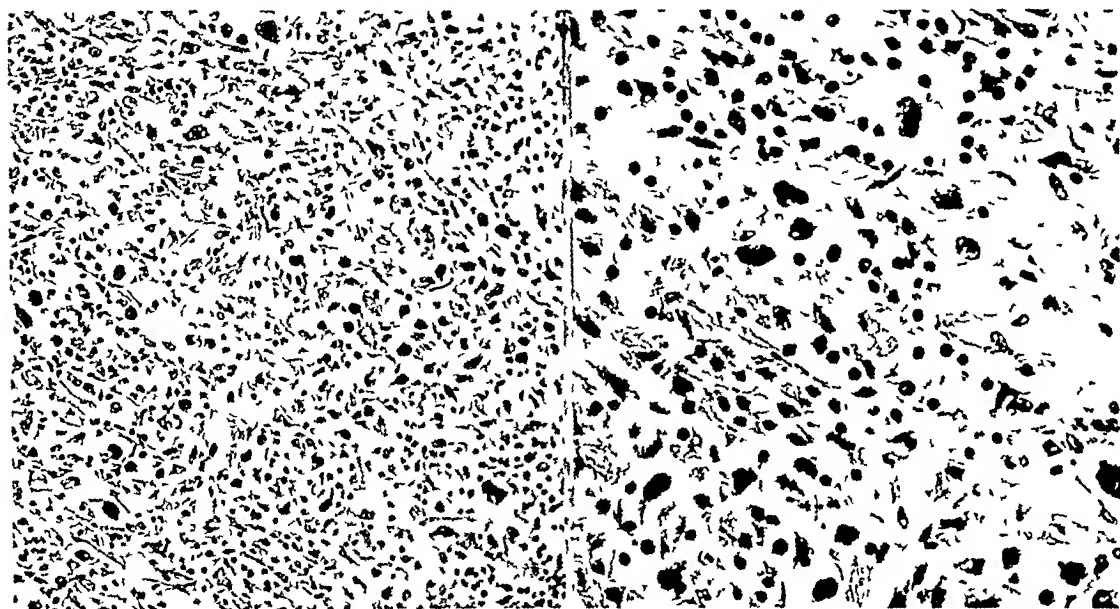


FIG 2—Photomicrograph of section of tumor of the anterior mediastinum ( $\times 122$ )

FIG 3—Photomicrograph of section of tumor of the anterior mediastinum ( $\times 393$ )

DISCUSSION—DR CARL EGGERS (New York)—There are several angles from which this case may be discussed. (1) The presence of an isolated Hodgkin's tumor in the mediastinum. (2) The treatment of Hodgkin's disease by surgery in general. (3) Removal of a mediastinal tumor, and the technic employed.

Most clinicians and pathologists, however, agree that a glandular tumor, usually multiple in character and showing on section typical structure and presence of certain cells including Dorothy Reed cells, lymphocytes, plasma cells, endothelial cells, eosinophilic leukocytes and multinucleated giant cells, may be regarded as a malignant granuloma or Hodgkin's disease.

The question which interests us as surgeons is whether Hodgkin's disease is at first a local disease, like a malignant tumor, and whether recognition and removal at this time may cure the disease, or whether it should always be considered a general affection of the lymphatic system.

There is ample evidence that at times removal of a single mass of involved Hodgkin's lymph nodes is followed by a long period of freedom from the disease or even an apparent cure, similar to carcinoma in which the primary tumor has been removed and apparent cure results until metastases make their appearance.

In the majority of cases the exciting agent is supposed to enter through the mucous membrane or through lesions of the skin and the cervical and supraclavicular nodes are usually primarily affected. At times the disease

first makes its appearance in the abdominal, mediastinal, inguinal or other nodes

Where the source of entry was in the case described by Doctor Muller is impossible to state. The tumor was found during a routine examination, and it is interesting to note that it did not respond to roentgen therapy. During the Annual Meeting of the American Association for Thoracic Surgery in 1928 Dr. William Lerche<sup>1</sup> reported an interesting case in which had developed successively Hodgkin's tumors in the left and right supraclavicular fossae and finally in the mediastinum. He performed incomplete operations followed by roentgen therapy. There was a clinical cure and the patient was in excellent health at the time of publication, 18 years after the onset of the disease and seven years after the last operation. With his characteristic attention to detail, Doctor Lerche has worked out the probable course of extension of the disease from the neck to the mediastinum and his article can be highly recommended to those interested in this subject.

The question may be asked whether Doctor Muller would have operated had he known in advance that the mass was an isolated Hodgkin's tumor. Though the surgical treatment of Hodgkin's disease is not popular at the present time, I believe that unless there is generalized disease present an attempt at removal of the primarily involved nodes, followed by roentgen therapy, is justified.

On the other hand, most of the more recent contributions stress the value of roentgen therapy alone. Clinically one may recognize favorable features of the disease, and less favorable ones. Localization in one area is held by most observers to be a favorable sign, and it is this variety which lends itself to surgery. In that sense Doctor Muller's case might have been considered surgical even had the diagnosis been known in advance, especially in view of the fact that it did not respond to roentgen therapy.

#### REFERENCE

- <sup>1</sup> Lerche, William. Hodgkin's Disease of the Neck and Mediastinum. Arch Surg, 18, 329, 1929.

## JEJUNAL INTUSSUSCEPTION

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THE classification of intussusception is, at times, confusing. That suggested by Peirce and Lindsay,<sup>7</sup> namely, ileocecal, ileocolic and enteric types, is quite satisfactory. The terms are self-explanatory with the possible exception of ileocolic, which begins as an enteric type, involving the terminal ileum primarily, and then passes through the more or less fixed ileocecal valve, and as it progresses, drags the cecum with it. While the term enteric covers all intussusceptions involving the small intestines, these might better be divided into ileal, jejuno-ileal and jejunal.

The cases involving the small intestine alone form a small but interesting group, and because of the distinctive features presented, it is felt that they should be considered separately.

The comparative frequency of intussusception involving the small intestine alone and that involving the small and large intestine, or the large intestine alone, has been discussed by several writers. The present problem, however, concerns itself with the incidence and comparative frequency of the true jejunal type. All reports and statistics in the literature were reviewed, and no consideration of this condition, as an entity, was found.

In Leichtenstein's series<sup>1</sup> of 593 cases there were recorded 178 enteric cases with only three jejunal types. Hutchinson<sup>2</sup> reported 134 cases which included one enteric case, which was of the jejunal type. Clubbe<sup>3</sup> reported one enteric (ileo-ileal) case in a series of 124. Fitzwilliams<sup>4</sup> 717 cases included 71 enteric and only four jejunal types. Elliot and Coriscaden<sup>5</sup> reported 300 cases with 28 enteric and seven jejunal types. Kassemeyer,<sup>6</sup> 92 enteric cases in a total of 192, with six jejunal types. Peirce and Lindsay,<sup>7</sup> 34 enteric cases in 335 (analysis of these 34 cases was not possible as individual case reports were not presented), Brown,<sup>8</sup> two enteric cases among 31, with no jejunal types, McIver,<sup>9</sup> 12 enteric in a total series of 81 cases (analysis of the enteric types not possible), Reisinger,<sup>10</sup> 13 enteric cases in a total of 38 with but two jejunal types, Close,<sup>11</sup> 11 enteric cases with only one jejunal type in a series of 185 cases, Petersen and Carter,<sup>12</sup> three enteric cases in a report of 64 cases (enteric analysis not possible), Robbins,<sup>13</sup> 34 cases with no enteric types, Mayo and Phillips,<sup>14</sup> 31 cases with no enteric types, Ladd and Gross,<sup>15</sup> five enteric cases in a total of 372 with no jejunal types, Miller and Workman,<sup>16</sup> seven enteric cases in a total of 21 with no jejunal types.

The records of the Cook County Hospital in Chicago were reviewed for a five year period (1931 to 1935, inclusive). Only 32 cases of intussusception

were found, among which there were four enteric types, none of which, however, occurred in the jejunum

From these statistics it is possible to calculate, with a fair degree of accuracy, the ratio of enteric cases to the total, of jejunal cases to the total, and of jejunal cases to enteric cases (Table I). With a total number of 3,284 cases considered, there were 462 enteric cases (ratio 17), with only 24 jejunal types (ratio 117). In other words, 14 per cent of enteric cases but only 0.9 per cent of jejunal type. When we consider that intussusception is not common, we realize what a small percentage of enteric types occur, and how rare jejunal types are.

TABLE I  
RATIO OF JEJUNAL TO GENERAL ENTERIC INTUSSUSCEPTION

Author	Date	Total Cases	Enteric Cases	Jejunal Cases	Ratio of Enteric to Total	Ratio of Jejunal to Total	Ratio of Jejunal to Enteric	Per Cent	
								Enteric	Jejunal
Leichtenstern	1873	593	178	3	1 3	1 197	1 59	33 %	0.5%
Hutchinson	1874	134	1	1	1 134	1 134		0.7%	0.7%
Clubbe	1907	124	1	0	1 124			0.8%	
Fitzwilliams	1908	717	71	4	1 10	1 179	1 17	10 %	0.5%
Eliot & Corcoran	1911	300	28	7	1 11	1 43	1 4	9 %	2 %
Kassemeyer	1912	192	92	6	1 2	1 32	1 15	50 %	3 %
Perrin & Lindsay	1921	335	34	No report	1 10			10 %	
Brown	1925	31	2	0	1 15			6 %	
McIver	1928	81	12	No report	1 7			14 %	
Reisinger	1930	38	13	2	1 3	1 19	1 6	33 %	5 %
Close	1931	185	11	1	1 17	1 185	1 11	6 %	0.5%
Petersen & Carter	1932	64	3	No report	1 21			5 %	
Robbins	1932	34	0	0					
Mayo & Phillips	1933	31	0	0					
Ladd & Gross	1934	372	5	0	1 74			1 %	
Miller & Workman	1935	21	7	0	1 3			33 %	
Cook County Hosp	1931-	32	4	0	1 8			12 %	
Total	1935	3,284	462	24	1 7	1 117	1 17	14 %	0.9%

NOTE: The 1,008 cases reported by Hess Arch. Pediat. 22:655, 1905 gave no statistics as to types.

**Case Report**—S. R., male, age nine, was first seen by Dr. E. B. Freilich March 6, 1936, complaining of intermittent, colicky abdominal pain for two days with repeated vomiting. He had been in perfect health previous to March 4, at which time the above symptoms began acutely. At the time of examination there was some distension and tenderness in the lower abdomen. No mass was palpable abdominally or rectally, but there was blood on the examining finger. Temperature 100° F, pulse 100. The urine was negative and the white blood count 19,050 with 82 per cent polymorphonuclear leukocytes. A provisional diagnosis of intussusception was made.

**Operation**—March 6, 1936, by Dr. Alfred A. Strauss. While under the anesthetic, a tumor could be palpated in the lower abdomen. The mass was exposed through a right rectus incision, and was found to consist of one and one-half feet of gangrenous small bowel, and in addition three feet more of gangrenous small bowel intussuscepted tightly with its mesentery. Because the intussusception could not be reduced, a block resection of the entire mass was performed, and an end-to-end anastomosis was accomplished, using two layers of silk and a few interrupted silk sutures. The patient made an uneventful recovery and was discharged after two weeks.

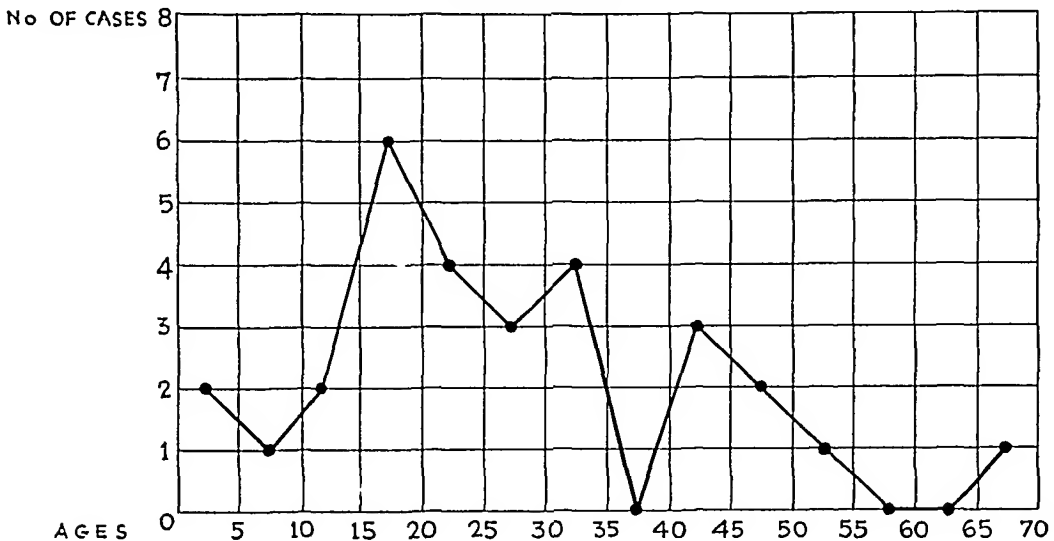
Gross pathologic examination revealed a double intussusception of jejunum into jejunum and into the first part of the ileum, with extensive gangrene of the jejunojejunal part, which, however, did not involve the ileum. This was confirmed by microscopic

examination. No abnormalities or apparent etiologic factors were found at the apex of the intussusceptum or in the intussuscipti.

The rarity of this condition, the absence of any etiologic factor, the age of the patient, *etc.*, prompted us to investigate all the cases reported in the literature (Table II).

*Sex and Age Incidence*—Twenty-nine cases were found reported from 1852 to 1934. There were 15 males and 13 females, one was not specified. This was particularly interesting, as in the series studied by Peim and Lindsay<sup>7</sup> the ratio of males to females was 2:1. While it is well known that the large majority of intussusceptions occur under two years of age, in our series the average age was 26.5 years, ranging from four months (Case 29) to 67 years (Case 21) (Chart I).

CHART I  
AGE INCIDENCE



This observation agrees with that of other writers who found that enteric intussusceptions are more common in adults. This being, therefore, an adult type of intussusception, it is interesting to note that our patient was only nine years of age.

In nearly all of these cases the symptoms were chronic in character and had existed over a period of weeks or even years, consisting of vague abdominal pains, or occasional gastro-intestinal upset. Usually, however, there was an acute stage with abdominal pain, nausea, repeated emesis and distension. In 13 cases a mass was palpable either rectally or abdominally, and in only eight cases were bloody stools noted.

Twenty of these 29 cases were operated upon, with six deaths (14 resections and anastomoses with four deaths, six reductions with two deaths). Seven were not operated upon but were diagnosed postmortem.

There were 18 simple jejunojejunal, nine double jejunal and two triple jejunal intussusceptions. Eleven cases were caused by polyp, two by lipomata and one each by a lymphosarcoma, myoma, sarcoma, papillary adenoma, fibroadenoma, enlarged mesenteric nodes, fibroma, polypoid adenocarcinoma,

TABLE II  
RESUMÉ OF THE 29 CASES OF JEJUNAL INTUSSUSCEPTIONS REPORTED IN THE LITERATURE

Author	Date	Sex	Age	Duration	Symptoms	Surgery	Result	Type	Etiology
1 Trevor <sup>17</sup>	1852	M	12	3 wks	Occ abdominal pain, acute onset of pain and emesis, palpable abd mass, negative rectal	None	Died	Double jejunal	Polyp of jejunum
2 Percock <sup>18</sup>	1873	F	19	1 mo	Occ abdominal pain, anemia, acute onset of abd pain and emesis, no palp mass or rectal blood	None	Died	Jejunojejunal	Polyp of jejunum
3 White <sup>19</sup>	1873	M	30	3 da	Acute onset of abd pain emesis and distension No mass or rectal blood	None	Died	Jejunojejunal	Polyp of jejunum
4 Reisinger <sup>10</sup>	1883	M	46	6 mo	Vague abd pain followed by acute pain and emesis Palpable mass in rt inguinal region Blood in stool	None	Died	Jejunojejuno-ileal	Lymphosarcoma of jejunum
5 Whipple & Turner <sup>6</sup>	1891	F	29	3 wks	Occ abd pain and constipation Sudden onset of pain emesis and distension No palp mass but rectal blood present	Reduction	Died	Jejunojejunal with volvulus	Polyp of jejunum
6 Reisinger <sup>10</sup>	1894	F	42		Hyperemesis gravidarum Abd mass palpable and rectal blood present	Resection	Died	Jejunojejunal	Lipoma of jejunum
7 Reisinger <sup>10</sup>	1894	F	28			Reduction	Good	Jejunojejunal	Myoma of jejunum
8 Eliot & Corcoran <sup>5</sup>	1896	F	19	36 hrs	Pain emesis distension and rectal blood, no palpable mass	None	Died	Jejunojejuno-ileal	Not determined
9 Eliot & Corcoran <sup>5</sup>	1900	F	23	5 da	Abd pain emesis and distension No rectal blood, no palp mass	Resection	Died	Jejunojejunal	Polyp of jejunum
10 Reisinger <sup>10</sup>	1901	M	44	6 wks	Pain diarrhea and emesis acutely setting in after vague abd distress Rectal blood but no abd mass present	None	Died	Jejunojejuno-ileal	Sarcoma of jejunum
11 Maurice <sup>1</sup>	1901	F	23	9 hrs	Vague abd pain followed by acute pain emesis rigidity and distension	Resection	Died	Jejunojejunal	Ten polyp of jejunum
12 Reisinger <sup>10</sup>	1902	F	16		Pain in abdomen, palpable tumor	Resection	Good	Jejunojejunal	Polyp of jejunum
13 Reisinger <sup>10</sup>	1902	M	48		No acute symptoms Palpable mass	Resection	Good	Jejunojejunal	Not determined
14 Willard <sup>22</sup>	1907	M	30	7 da	Obstipation Acute onset of pain emesis distension tenderness and rigidity No rectal blood or palpable mass W B C 9 000	Resection	Good	Jejunojejuno-ileal	Subperitoneal lipoma



# JEJUNAL INTUSSUSCEPTION

15	Ross & Page <sup>21</sup>	1907	M	17	26 da	Symptoms of perforation following severe typhoid fever	None	Died	Jejunojejunal	Not determined
16	Elot & Corscaden <sup>5</sup>	1908	F	13	40 da	Occ emesis and bloody stools			Jejunojejunal	Not determined
17	Ludlow <sup>24</sup>	1916	M	18	3 mo	Occ epigastric distress Acute onset of pain and emesis Palp mass in R U Q, but no rectal blood	Resection	Good	Jejunojejunal	Papillary adenoma of jejunum
18	Oden <sup>25</sup>	1919	M	22	2 yrs	Abdominal pain and constipation, acute onset with pain emesis and distension, palpable mass Roentgenogram showed a prolapsed colon	Resection	Good	Jejunojejunal	Two pedicled fibroadenomas
19	Harris <sup>26</sup>	1920	F	1½	24 hrs	Rectal hemorrhage and palp rectal mass collapse	Reduced	Good	Triple jejunal	Enlarged mesenteric nodes
20	Louis & Moorehead <sup>7</sup>	1922	M	54	6 yrs	Recurrent G I upsets followed by an acute onset of pain and distension, no palp mass or rectal blood	Reduced	Good	Double jejunal	Fibroma of jejunum
21	Green <sup>23</sup>	1928	M	67	6 mo	Continuous abd pain, palp abd mass in L U Q with negative stools	Resection	Good	Jejunojejunal	Leiomyoma jejunum
22	Green <sup>29</sup>	1928	F	34	25 da	Nausea and occ emesis, acute onset of pain emesis and tenderness in the R L Q No palp mass or rectal blood	Resection	Good	Jejunojejunal	Polypoid adenocarcinoma
23	Thorleifson <sup>30</sup>	1929	M	32	1 wk	Acute onset of emesis and abd tenderness with sudden collapse No palp mass or rectal blood W B C 26 900	Reduced	Died	Jejunojejunal	Not determined
24	Somerville-Large <sup>31</sup>	1929	M	17	20 hrs	Abd pain and emesis, palp mass but no rectal blood	Resection	Good	Double jejunal	Polyp of jejunum
25	Washburn <sup>32</sup>	1929	M	21	36 hrs	Emesis, abd pain and tenderness, palp abd mass and rectal blood	Resection	Good	Multiple jejunal	Multiple polyps of jejunum
26	Reisinger <sup>10</sup>	1930	M	26		Acute pain and distension, palpable abd mass but no rectal blood		Died	Double jejunal	Small tumor of jejunum
27	Reisinger <sup>10</sup>	1930	F	8½		Meteorism Negative rectal and no palpable mass	Resection	Good	Jejunojejuno-ileal	Polypus (?)
28	Marr & Marver <sup>33</sup>	1932	F	40	4 yrs	Occ abd pain and emesis followed by acute onset with tenderness No mass or rectal blood Diagnosed by roentgen ray	Reduced	Good	Jejunojejunal	Polyposis
29	DeTarnowsky & Sarma <sup>34</sup>	1934		4 mo	4 mo	Hematemesis, distension, palpable abd mass, rectal blood, cachexia	Resection	Died	Jejunojejunal	Infiltrating papilloma

leiomyoma, infiltrating papilloma, undifferentiated small tumor and by typhoid fever. In four cases the etiology was not determined (Table II)

**DISCUSSION**—From the viewpoint of etiology these jejunal cases are very interesting. While only five per cent of all intussusceptions occur in adults, the jejunal types are rarely seen in infants or children. In a large percentage of children with intussusception no demonstrable cause is found, while in the jejunal cases a tumor or some other abnormality of the intestine was the cause in most cases—25 of the 29 cases reported (Table II). If we may consider enteric cases in general, in addition to the above etiologic factors, cases are presented with Meckel's diverticulum,<sup>9</sup> tuberculous ulceration,<sup>35</sup> hemangio-endothelioma,<sup>9</sup> congenital stenosis of the ileum,<sup>46</sup> infectious diarrhea,<sup>36</sup> adhesions,<sup>37</sup> *etc.*, as the cause. It is difficult to account for the cases in which no etiologic factor was found.

Nothnagel's<sup>38</sup> theory of spasm and irregular peristaltic movement in the intestinal wall produced by faradic currents in dogs, Fitzwilliams'<sup>4</sup> explanation of the difference in rapidity of growth in the different parts of the intestinal tract, Alvarez's<sup>39</sup> idea that antiperistalsis may normally occur, and Shaw's<sup>40</sup> theory of peristalsis versus antistalsis as a normal physiologic muscular activity, may all be applicable.

Several theories as to the causation of intussusception in the presence of a tumor in the intestinal wall are advanced. A tumor offers an object which wave like contractions of the circular muscles can grasp and force onward by exerting traction at its point of attachment, pulling it inward and downward, thus initiating an intussusception. On the other hand, the mechanism may be simply that of a spasmodic contraction of the gut around the tumor with inhibition of the gut immediately distal to it, so that the contracted part easily slips into the distal part.

**Pathology**—The pathology of acute intussusception is the same regardless of the type. The entering sheath (intussusceptum) is invaginated into the receiving sheath (intussusciens). The mesenteric attachment of the invaginated bowel produces great tension on the mesenteric side of the intussusceptum, causing a curve with its convexity towards the mesentery, particularly marked at the apex. This causes a slit like opening in the intestine, with the slit directed towards the mesenteric side of the intussusciens. The bowel regards the intussusceptum as a foreign body which is violently stimulating its lining mucosa, and is, therefore, constantly endeavoring to establish a contraction ring about it in order to squeeze it along the intestine. The effect of this contraction is exerted along the enteric mesentery with the result that changes similar to those seen in a strangulated hernia develop in the invaginated bowel through which the prolapsed mesentery passes, with the development of gangrene as the arterial vessels are constricted.

For this reason a simple invagination of the bowel that does not constrict the mesentery may result in slight changes in the bowel wall, so that the condition may be tolerated for weeks, months, and even years.

An intussusception artificially produced under normal physiologic conditions tends to reduce itself, and if it is to persist for any length of time, there must be present either some gross lesion in the bowel wall, or some general abnormal condition which increases bowel irritability, upsetting normal peristalsis sufficiently to cause one segment of bowel to telescope into another.

The classical picture of intussusception in infancy is rarely seen in these jejunal types, except in the acute stages of the disease. In most cases a chronic history of abdominal pain, occasional emesis, epigastric distress and constipation may be elicited, followed by an acute onset of abdominal pain, repeated emesis, distension, tenderness and muscle spasm. Collapse may occur as an initial symptom. There may or may not be a palpable abdominal mass, and in only 25 per cent of the cases was there any rectal blood or blood tinged mucus noted.

The treatment of these cases is preferably surgical. Paul Barbette, in 1676, suggested opening the abdomen in cases of obstinate volvulus or intussusception. In 1874, Jonathan Hutchinson<sup>2</sup> performed the first abdominal section with successful reduction of an intussusception. Hipsley,<sup>41</sup> and Koch and Oerum<sup>42</sup> favored the method of reduction by enemata. Arntzen and Helsted,<sup>43</sup> and Retan and Stephens<sup>44, 45</sup> advocated reductions by the instillation of a barium enema. However, the consensus of opinion today favors early surgery.

**SUMMARY**—(1) An analysis of 3,284 cases, which include the 32 cases herewith reported from the Cook County Hospital in Chicago, reveals that enteric intussusceptions occur in the ratio of 1:7 (14 per cent), and that jejunal intussusceptions occur in the ratio of 1:117 (0.9 per cent [Table I]).

(2) Twenty-nine cases were found in the literature from 1852 to 1936, and one more case is herewith reported.

(3) Jejunal intussusception, as a rule, occurs in adults and is associated with some definite, local pathologic condition. The symptoms are of a chronic nature, but tend to become acute as the mesentery is constricted giving rise to a clinical picture of obstruction. A palpable abdominal mass or blood in the rectum may or may not be present.

(4) The pathogenesis and pathology of jejunal intussusceptions are discussed in their relation to possible symptomatology.

#### CONCLUSIONS

Jejunal intussusception is rare, in comparison with those occurring in the ileum and sigmoid colon.

There are certain clinical features which may make possible the early diagnosis of this condition, so that early operation may be undertaken.

#### BIBLIOGRAPHY

- <sup>1</sup> Leichtenstern, O. Vierteljahresschrift f. d. prakt. Heilk., 118-119, 189-221, 1873 and 120, 59-108 and 121, 17-49, 1874.
- <sup>2</sup> Hutchinson, J. A Successful Case of Abdominal Section for Intussusception. Tr. Roy. Med. and Chir. Soc., 57, 31, 1874.
- <sup>3</sup> Clubbe, C. P. Diagnosis and Treatment of Intussusception, 1907.

- <sup>4</sup> Fitzwilliams, D C L The Pathology and Etiology of Intussusception from the Study of 1000 Cases *Lancet*, 174, 628, 1908
- <sup>5</sup> Eliot, E, and Corscaden, J A Intussusception with Special Reference to Adults *ANNALS OF SURGERY*, 53, 169, February, 1911
- <sup>6</sup> Kassemeyer, E Tumor Invagination of the Intestine *Deutsche Ztschr f Chir*, 118, 205, 1912
- <sup>7</sup> Perrin, W S, and Lindsay, E C Intussusception Monograph Based on 400 Cases *Brit J Surg*, 9, 46, 1921
- <sup>8</sup> Brown, H B, Jr Acute Intussusception in Children *ANNALS OF SURGERY*, 82, 637, 1925
- <sup>9</sup> McIver, M A Intussusception of the Small Intestine with Special Reference to Meckel's Diverticulum *New England Med Jour*, 199, 453, September 6, 1928
- <sup>10</sup> Reisinger, M Acute and Subacute Intussusception on Basis of Intestinal Polyp *Deutsche Ztschr f Chir*, 227, 255, 1930
- <sup>11</sup> Close, H G Acute Intussusception Analysis of 363 Cases *Guy's Hosp Report*, 81, 436, October, 1931
- <sup>12</sup> Petersen, E W, and Carter, R F Acute Intussusception 64 Cases *ANNALS OF SURGERY*, 96, 94, July, 1932
- <sup>13</sup> Robbins, F R Acute Intussusception *ANNALS OF SURGERY*, 95, 830 1932
- <sup>14</sup> Mayo, C W, and Phillips, J R Acute Intussusception 31 Cases *Surg Clin N A*, 13, 995, August, 1933
- <sup>15</sup> Ladd, W E, and Gross, R E Intussusception in Infancy and Childhood *Arch Surg*, 29, 365, 1934
- <sup>16</sup> Miller, G G, and Workman, E W Clinical Survey of 21 Intussusceptions *Canad M A J*, 32, 660, June, 1935
- <sup>17</sup> Trevor, M D Remarkable Case of Intussusception *Am J Med Sci*, 49, 277, January, 1852
- <sup>18</sup> Peacock, J B Intussusception of the Upper Part of the Small Intestine *Tr Path Soc London*, 24, 108, 1873
- <sup>19</sup> White, W H Intussusception of Jejunum in an Adult Due to a Polypus *Tr Path Soc London*, 41, 121, 1873
- <sup>20</sup> Whipham, T, and Turner, G R A Case of Intussusception and Volvulus *Clinical Soc Trans*, 24, 95, 1891
- <sup>21</sup> Maurice, W J A Case of Jejunal Intussusception Multiple Growths in Jejunum *Lancet*, 1, 248, 1901
- <sup>22</sup> Willard, H G Intussusception Caused by a Subperitoneal Lipoma of Jejunum *Tr Chicago Path Soc*, 7, 174, 1907
- <sup>23</sup> Ross, G G, and Page, H F Acute Intussusception in the Adult *Am J Med Sci* 134, 841, 1907
- <sup>24</sup> Ludlow, A I Papillary Adenoma of the Jejunum with Intussusception *Chinese M J*, 32, 425, 1918
- <sup>25</sup> Oden, R J E Intuss of the Jejunum with Two Pedunculated Fibroadenomata *Surg, Gynec and Obstet*, 29, 489, 1919
- <sup>26</sup> Harris, H A H Triple Intussusception of the Jejunum *Guy's Hosp Gazette*, 34, 425, 1920
- <sup>27</sup> Louis, E, and Moorehead, D Double Intuss of the Upper Jejunum *Surg Clin N A*, 3, 1103, August, 1923
- <sup>28</sup> Green, N W Polypoid Adenocarcinoma of the Jejunum with Intuss *ANNALS OF SURGERY*, 88, 1113, 1928
- <sup>29</sup> Green, N W Leiomyoma of the Jejunum with Intussusception *ANNALS OF SURGERY*, 88, 1114, 1928
- <sup>30</sup> Thorleifson, W H A Case of Jejunal Intuss *Canad M A J*, 30, 395, 1929

- <sup>31</sup> Somerville-Large, W C Double Jejunal Intuss with Polypus Brit J Surg, 17, 340, 1929
- <sup>32</sup> Washburn, W W Multiple Polypi of the Jejunum with Intussusception California and West Med, 30, 260, 1929
- <sup>33</sup> Marr, N G, and Marner, O A Intussusception of the Jejunum Lancet, 1, 392, August 20, 1932
- <sup>34</sup> DeTarnowsky, G, and Sarma, P J Polyp of Jejunum Causing Intuss Surg Clin N A, 14, 879, August, 1934
- <sup>35</sup> Turner, G Intussusception Lancet, 1, 169, 1914
- <sup>36</sup> Fitzwilliams, D C L Spontaneous Reduction of Intussusception Practitioner, 109, 93, 1922
- <sup>37</sup> Coutts, F J Fixation of the Cecum in Chronic Intussusception Brit M J, 1, 508, March 24, 1923
- <sup>38</sup> Nothnagel Specielle Pathologie und Therapie, A Holder 17, 385, 1903
- <sup>39</sup> Alvarez, W C, and Mahoney, L J Peristaltic Rush in the Rabbit Am J Physiol, 69, 211, July 1, 1924
- <sup>40</sup> Shaw, H A Partial or Complete Intussusception Northwest Med, 17, 283, October, 1918
- <sup>41</sup> Hipsley, P L Intuss and Its Treatment by Hydrostatic Pressure M J Australia, 2, 201, 1926
- <sup>42</sup> Koch, A, and Oerum, H Intussusception in Child 400 Danish Cases Edinburgh M J, 9, 227, 1912
- <sup>43</sup> Arntzen, L, and Helsted, A Acta chir Scandinav, 65, 70, 1929
- <sup>44</sup> Retan, G M Nonoperative Treatment of Intussusception Am J Dis Child, 33, 765, May, 1927
- <sup>45</sup> Stephens, V R Acute Intuss Am J Dis Child, 35, 61, January, 1928
- <sup>46</sup> Warwick, W J Intuss Supervening on Congenital Stenosis of Ileum Brit M J, 1, 804, May 12, 1923

## CONGENITAL ATRESIA OF THE INTESTINE

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CONGENITAL anomalies of the gastro-intestinal tract are of interest not only to the embryologist, but also to the surgeon, since successful treatment depends upon early operation. These deformities occur more frequently than is usually appreciated.

The lesions may be classified into those manifesting themselves immediately after birth, and those giving symptoms only in later life.<sup>1</sup> In the first group the atresias, stenoses, and occasionally volvuli are usually the cause of complete obstructions. The malrotations or incomplete rotations, elongated ligaments and volvuli constitute the types in the latter group.

The results obtained in instances of stenoses and atresias are uniformly poor. Davis and Poynter<sup>2</sup> collected 392 cases of congenital occlusion of the intestines, more than 50 per cent of which had multiple atresias from the duodenum to the rectum. None of this group of cases recovered. Bigfield,<sup>3</sup> in 1928, reported 194 cases. Fifty-eight were atresias of the duodenum, 103 of the small intestine, and 33 of the colon. There were only two cases successfully operated upon up to that time, one reported by P. Fokens, in 1910, and another by N. P. Ernst, in 1915.

Since 1900, necropsy has been performed upon 28 cases at the Great Ormond Street Hospital, London, none of which had been operated upon.

The first operative attempt was made by Bland-Sutton.<sup>4</sup> He also contributed much in explaining the possible etiologic factors involved in the production of these deformities.

The first successful operation, by Fokens, was an anastomosis between the separated segments. Ernst's case, in 1915, was an anastomosis between the duodenum and ileum, in which the ileum was brought up over the colon. Richter<sup>5</sup> reported a case successfully treated by posterior gastro-enterostomy. Sweet and Robertson<sup>6</sup> reported an atresia of the duodenum in which the jejunum and stomach were anastomosed. Due to continued vomiting of bile the anterior surface of the second part of the duodenum was joined to the jejunum. Bolling<sup>7</sup> reported three successfully treated cases of duodenal atresia. Duodenojejunostomy was the operation performed in each instance. Webb and Wangenstein,<sup>8</sup> in 1931, stated that there were only nine instances of survival from the operation. There have probably been other operative cases that have never been reported.

Atresias and stenoses of the gastro-intestinal tract are found in one of every 4,000 children. The occurrence of these anomalies in the duodenum

and small intestine is thought to be one in every 20,000 infants. Stenosis is considered more frequent than atresia, complete occlusion occurring most frequently in the duodenum near the ampulla of Vater.

There is no unanimity of opinion regarding the etiology of these conditions. According to many the obstruction is due to a persistence of epithelial buds in the intestines. Others consider intra-uterine inflammations as being the main cause. Vascular changes are also thought to be a factor.

Loitman<sup>9</sup> classifies the various hypotheses explaining these conditions into two main groups: I. Malformation or arrest in the course of normal development. II. Disease of the fetus.

The following causes come under Group I: (1) Anomalies in the development of the mesenteric artery with consequent malformation of the bowel. (2) Abnormal twisting of the mesentery in the course of normal bowel rotation with occlusion of the blood vessels. (3) Anomalies of development of the vitelline duct. (4) Bland-Sutton's theory that occurrence took place at the site of an "embryological event", that is, at the site of epithelial outgrowth of the pancreas and liver from the duodenum, a developmental error occurred. (5) Tandler, in 1900, demonstrated from experimental studies that the Vaterian segment of the duodenum is occluded by epithelial proliferation during the second month of fetal life. He concluded therefore that in these conditions there was a persistence of these physiologic epithelial obstructions.

Loitman mentions under Group II: (1) Embolus in superior mesenteric artery. (2) Fetal peritonitis (Fielder, 1864). (3) Syphilis. (4) Intra-uterine enteritis (Thorel, 1899). (5) Volvulus (Gaitner, 1863). (6) Intussusception of a loop of intestine with absorption of necrotic bowel (Chiari, 1888).

With such a variation of causative factors it is doubtful which play important rôles. There are probably other conditions which play some part in these anomalous conditions.

The symptoms caused by these lesions are those of intestinal obstruction, of which vomiting is by far the most prominent, although it is possible for the condition to exist and this symptom to be absent. The vomiting is usually persistent and for the most part directly associated with the intake of food. The vomitus may consist of only ingested material, or, if it persists and the occlusion is below the ampulla of Vater, it may contain bile. Blood is occasionally present in the vomitus. Scant or absent bowel movement is usual. There may be the passage of some mucoid material from the rectum and occasionally bile may be present in those cases where the obstruction is proximal to the opening of the bile duct. Distention is prominent, the degree depending upon the site of the occlusion, as in all types of intestinal obstruction.

The diagnosis is not difficult, but it is sometimes impossible to localize the site of the obstruction. The greatest confusion occurs in cases with spasm of the pylorus and pyloric stenosis. Vomiting is commonly seen in newborn infants but if it continues some type of congenital obstruction should be

considered. Reversed peristalsis is frequently seen in instances of pyloric stenosis but is not often present in deformities below this site. The vomiting at the onset in pyloric stenosis is often projectile in character but may not be present in atresia. Roentgenologic examination should be made early in these conditions, not only to confirm the diagnosis but also to locate the site of the obstruction. Flat films of the abdomen will reveal shadows of gas. With the child held in the erect position distinct pockets or fluid levels may be seen. The use of barium both by mouth and by rectal clysis may be of aid in



FIG 1—(Case 1) Roentgenogram after barium had been given by mouth and by rectum. The dilated loops of intestine are shown with the blind ends of the ileum.

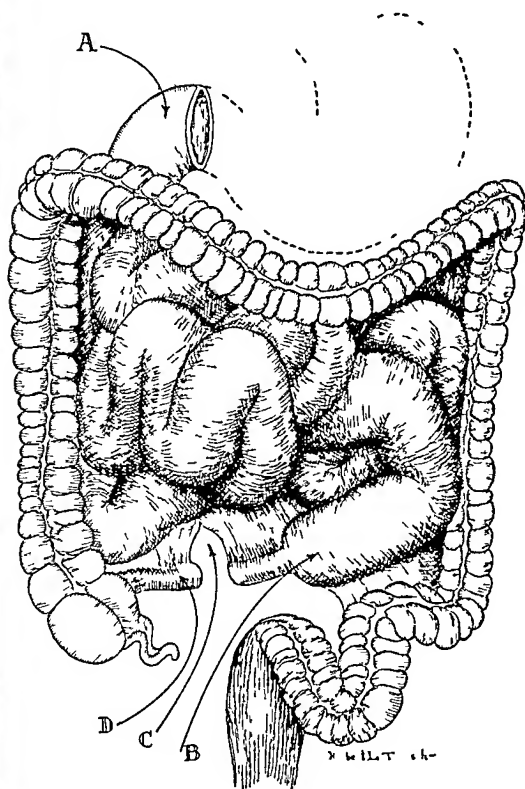


FIG 2—(Case 1) Showing the atresia occurring below the dilated portion of the lower ileum. A hiatus in the mesentery is also to be noted.

localizing the lesion but is not always necessary in the diagnosis. Other congenital deformities, such as imperforate anus, esophageal stenosis, defective rotation associated with volvulus, and internal hernia, must always be considered.

Ladd<sup>10</sup> stressed the fact that examination of the stools may be of aid in determining a complete occlusion. Meconium begins to collect in the intestine after the third fetal month. Any occlusion occurring before this time precludes the finding of the normal elements of meconium in the stools. Keratinized epithelium is the most constant substance and easiest to recognize in the stools. According to Ladd these cells may be seen in the smears dried with ether and stained with Sterling's gentian violet. If these keratinized epithelial cells are not found, it indicates the presence of atresia.



# INTESTINAL ATRESIA

## CASE REPORTS

**Case 1**—Baby G, female, born December 2, 1935 It was immediately noticed that everything taken by mouth was promptly vomited The child was full term and apparently a normal infant A gastro-intestinal roentgenologic series was made 18 hours after birth and showed barium passing through the stomach and duodenum and into the small intestine There was a large dilated loop of intestine occupying the left upper quadrant of the abdomen This contained a small amount of barium A barium enema was given and revealed small streaks along the colon, this was not well visualized but appeared in ribbons (Fig 1)



FIG 3—(Case 2) Flat roentgenogram showing the dilated loops of small intestine above the site of obstruction

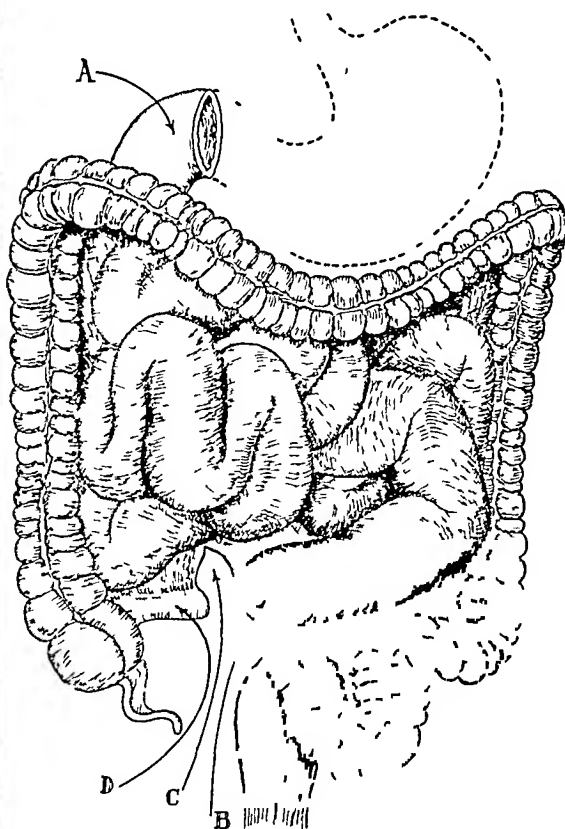


FIG 4—(Case 2) Showing the site of atresia in the lower ileum The proximal portion is markedly dilated The defect extends down into the mesentery

On December 4, 1935, the abdomen was opened There was a large dilated loop of small intestine which extended from the duodenojejunal junction more than halfway to the cecum At its distal tip it narrowed to about one centimeter and extended for another six centimeters, where it ended in a blind pouch There was a definite hiatus both in the gut and mesentery From this atresia the continuity of the gut began and was normal except for being collapsed (Fig 2) A tube was inserted in the proximal loop of intestine with no attempt at anastomosing the separated ends Glucose and saline were given subcutaneously before and after operation Only a small amount of gas and no fluid drained from the enterostomy tube The baby died 15 hours after operation

**Case 2**—Baby M A C, female, age three days, was admitted to the Henrietta Eggleston Hospital for Children after having vomited everything taken since birth The vomitus consisted of greenish material The first three stools were soft and mucoid with a greenish tint The last was dark in color, giving the appearance of bile The child was markedly dehydrated The skin was dry and hot The abdomen was tense and distended, more so above the umbilicus Peristalsis was visible and active

A gastro-intestinal roentgenologic series showed the stomach and upper small intestine distended with gas. The bowel terminated in a blunt end in the lower midabdomen (Fig 3).

An immediate operation was performed after having given glucose and saline subcutaneously. Distended loops of small intestine were immediately encountered. There was an abrupt end of this distended intestine in the lower right quadrant within a few inches of the cecum. There was no communication between the blind ends of the intestines. The large intestine was collapsed down to about one centimeter in diameter (Fig 4). An enterostomy was performed but no attempt at anastomosis was made. A blood trans-



FIG 5—(Case 2) Roentgenogram after barium enema showing the patency of the large intestine. The ileostomy tube is seen in situ.

fusion was given immediately. Convalescence was very stormy, complicated by dehiscence of the abdominal wound, with an intussusception into the enterostomy. The dilated small intestine acted as a pocket into which the upper limb of the intestine intussuscepted itself. It was necessary on seven occasions to administer ether in order to reduce the intussusception. On many occasions the intestine would prolapse through the stoma and would reduce without manipulation.

After the third week postoperative no attempt was made to replace the dilated loop which was allowed to remain on the abdominal wall. The ileostomy tube came out on the twelfth day postoperative leaving a fistula in the exteriorized loop of intestine. There was no digestion or irritation of the skin of the abdominal wall from the drainage from the fistula. Several days after operation a barium enema was given, which showed

the barium to flow from the rectum to the cecum (Fig 5) The caliber of the bowel was small and spastic One month after the first operation the entire exteriorized intestine was freed and a segment several inches long was resected The intestine was then anastomosed laterally Convalescence from this procedure was uninterrupted

The medical management of this case played an extremely important part in its successful outcome It is interesting to note that during the seven weeks the infant received a total of 38 subcutaneous injections of Hartman's solution, four blood transfusions, and 5 per cent glucose solution on numerous occasions Nothing by mouth was given for the first day, then small amounts of water and on the third day a milk formula was started

It has now been 18 months since the last operation and the child has had no disturbance She has taken full diet and weight gain has been normal

COMMENT—Although these lesions are thought to be infrequently encountered, they occur often enough to reemphasize their importance If congenital atresia is diagnosed early and adequate surgical treatment instituted, it is possible to avoid a fatal issue It is believed, in spite of the high mortality rate, that these infants should all be given the benefit of operative intervention

There is an extremely variable pathologic picture encountered The presence of multiple stenoses of the small intestine assures practically 100 per cent mortality It is not always possible to determine at the time of operation if such exists Above the atresia or stenosis the intestine is usually enormously dilated The wall is greatly thickened, containing all of the layers of the normal intestine In the stenosis there is a compression of the wall, giving the appearance of a ribbon The muscle layers may at times appear thickened The stenoses are practically complete but occasionally a very small lumen may be seen In this type of lesion the use of barium as a contrast medium will make the obstruction complete In the multiple lesions there may be intervening segments of normal intestine The entire segment is associated with atony The imperforation in the atresias may occur directly with the dilated loop (proximal), or as in the first case reported, a short distance distal to this point Very rarely is there a connection between the two blind ends of the gut When such exists it is a very firm fibrous cord The hiatus extends not only through the bowel but perhaps into the mesentery Atresias and stenoses occur usually independent of each other Multiple atresias are not as commonly encountered as multiple stenoses Congenital anomalies of the remainder of the gastro-intestinal tract or of other organs may be associated

Treatment in these cases should always be surgical, before dehydration, alkalosis and demineralization have occurred The newborn is able to withstand operative manipulations surprisingly well, provided adequate preparation is given The use of fluids, preferably in the form of Hartman's solution and blood transfusions before and after operation, aids in preventing shock and dehydration

The procedure carried out must vary with each individual case Adequate exposure is necessary for complete exploration of the abdominal cavity This must always be done to determine the multiplicity of lesions, although

shock is associated with evisceration, it is felt that this is essential to examine the individual segments of intestine

In the two cases reported, palliative enterostomy was the procedure of choice. In both cases signs of complete obstruction were manifested. The proximal intestinal walls were edematous and reddened and a slow decompression was thought advisable. At the same time it was possible to definitely determine that other lesions were not present. Entero-anastomosis is the most desirable procedure but is not always possible. The time required to perform either this anastomosis, or an entero-anastomosis and an enterostomy above, increases the degree of shock in these infants. The shortest and simplest procedure should give the best results, although secondary operations will always be necessary before establishing the continuity of the gut.

#### SUMMARY

Two cases of single congenital atresias involving the same portions of the small intestine are reported. One patient was operated upon three days after birth with complete recovery. The primary operation performed in each instance was a palliative ileostomy. In the successful case this procedure was later followed by a resection of the portion of the intestine with lateral anastomosis. It became necessary to do this due to a chronic intussusception developing in the stoma of the ileostomy. A review of the more common theories of formation of these peculiar anomalies is given. The preliminary and postoperative administration of glucose is advised. Haitman's solution and blood transfusions plays an important rôle in the successful treatment of these conditions. Early operation should be performed in all cases of complete stenosis and atresia. When vomiting in the newborn becomes persistent, congenital gastro-intestinal lesions should be suspected and ruled out if the only opportunity for recovery is to be afforded the infant.

#### REFERENCES

- <sup>1</sup> Losee, J. R. Some Congenital Anomalies of the Gastro-Intestinal Tract. *Bull. Lying-In Hospital, City of New York*, 18, 576-579, July, 1927.
- <sup>2</sup> Davis, D. L., and Poynter, C. W. M. Congenital Occlusions of the Intestine. *Surg., Gynec., and Obstet.*, 34, 35, 1922.
- <sup>3</sup> Birgfield, E. Congenital Atresia of the Small Intestine. *Zentralbl. f. Chir.*, 55, 1548-1553, June, 1928.
- <sup>4</sup> Bland-Sutton, J. Imperforate Ileum. *Am. Jour. Med. Sci.*, 98, 457, 1889.
- <sup>5</sup> Richter, H. M. Surgery of Gastro-Intestinal Tract in Children. *Abts. Pediatrics*, 3. Saunders Co., Philadelphia, 1924.
- <sup>6</sup> Sweet, G. B., and Robertson, C. A Case of Congenital Atresia of the Jejunum (With Recovery). *Arch. Dis. Childhood*, 2, 186, June, 1927.
- <sup>7</sup> Bolling, Richard W. Congenital Intestinal Obstruction. *Bull. New York Acad. Med.*, 4, 519-522, April, 1928.
- <sup>8</sup> Webb, C. H., and Wangenstein, Owen H. Congenital Intestinal Atresia. *Am. J. Dis. Child.*, 41, 262, February, 1931.
- <sup>9</sup> Loitman, Clara. Congenital Occlusion of the Intestine. *Boston M. and S. J.*, 197, 21-24, July, 1927.
- <sup>10</sup> Ladd, W. E. Congenital Obstruction of the Small Intestine. *J. A. M. A.*, 101, 1453-1458, November, 1933.

# RECTAL PROLAPSE

## EXPERIENCE WITH THE ELASTIC LIGATURE

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SO MANY procedures for the treatment of rectal prolapse have been advanced that it was thought worthwhile to report our very satisfactory experience in three cases treated by the very old and simple method of elastic ligature, recently rediscovered by Mont Reid<sup>4</sup> and further reported upon by Owen Wangensteen<sup>5</sup> Weinlechner,<sup>6</sup> in 1883, was the first one to use an elastic ligature, though Copeland, Howship, Busche and Greenhag had employed the same principle using different material such as silk, catgut, *etc*

Weinlechner's first case was in a child of eight months. It was an operation of necessity as the prolapsed rectum had been torn in attempting to replace it. The method employed was simply the occlusion of the blood supply to the prolapsed portion of the rectum by means of an elastic ligature tied over a stiff rubber tube introduced into the rectum. The rectum healed satisfactorily after four weeks. In 1886 he<sup>7</sup> reports three similar cases treated in the same way with good results. Following this, use was made of the method by von Albert, Allingham, Blandin, Hofmohl, Kleeberg, Marchal and Mikulicz.

Bakes,<sup>1</sup> in 1900, reports three cases, two were very satisfactory but the third died of peritonitis. At autopsy the cause for the peritonitis was found in a perforation at the site of the elastic ligature. He advances two reasons in explanation of this catastrophe. First, the elastic ligature was apparently drawn too tightly so that it cut through before firm serosal adhesions had formed, and secondly, before ligation undue traction was placed on the prolapse by means of a bullet forceps. This is the only mortality which was found recorded in the literature.

Kleeberg, in 1879, employed a similar method but simply used the elastic ligature as a means of hemostasis until he had amputated the prolapse and sutured the contiguous margins. Matas in discussing Reid's paper, in 1933, described a case in which he had used a similar procedure with success in 1894. Amputation of the prolapse was popularized by Mikulicz<sup>3</sup> and, in 1889, he reports seven successful amputations without a mortality. However, Lenormant, in 1907, states that the danger of peritonitis is at least 10 per cent.

With the advent of antiseptic surgery, this method fell into disuse, though one case is reported by von Serafini in 1906. Bauer,<sup>2</sup> in 1912, in a very comprehensive and excellent paper on the treatment of prolapse, stated that the cause for discontinuance of this method was the severe pain after the application of the ligature, retention of urine and difficulty in expelling gas.

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Since its rediscovery by Reid in 1925, four cases have been reported by him and one by Wangenstein with good end-results and without any of the above mentioned unpleasant symptoms. This has also been our experience in the following three cases.

**Case 1**—G. O., male, age 40, was admitted to the University Hospital in December, 1933. For some time prior to October, 1933, he had been constipated. One day he noticed a protrusion of his rectum which he replaced. This recurred at the next bowel movement, and at each succeeding one, so that he was unable to obtain a satisfactory evacuation. This difficulty increased up until the time of admission. His rectum would prolapse without the slightest amount of straining.

On examination a prolapse of about five inches of the rectum was seen. There was no etiologic explanation for its occurrence. In every other way he appeared to be in the best of health. Operation was decided upon and because of the absence of any etiologic factor it was thought better to perform a laparotomy. At the same time the possibility of performing a Moschowitz operation—obliteration of the culdesac of Douglas—was kept in mind. The depth of the culdesac would have made this operative procedure exceedingly difficult, so that removal of the prolapse by means of an elastic ligature was decided upon.

With the peritoneal cavity opened, we were also able to be absolutely certain that no loop of small intestine was contained in the prolapse. At operation, the rectum and sigmoid appeared to be perfectly normal. The prolapse readily recurred even under an inhalation anesthetic. With the hand in the abdomen, traction was made on the prolapse until all the redundancy of the sigmoid had been taken up. The small intestines were then packed out of the pelvis. In order to be certain not to injure the urethra a sound was introduced into the bladder. A firm rubber tube about three-quarters inch in diameter was inserted into the rectum for a distance of eight inches. A heavy rubber band was placed near the mucocutaneous junction, tightly encircling the prolapse. The prolapsed rectum rapidly became cyanotic and the next day was gangrenous. Thirteen days after operation, following an attempt to remove the slough, the patient had a profuse hemorrhage which stopped spontaneously. Three days later he expelled both the tube and the slough. At time of discharge, 22 days after operation, rectal examination revealed a normal rectum with slight relaxation of anal sphincter.

*Follow Up*—He was not seen again until four months later when, much to our chagrin, he returned with a stricture which admitted only the tip of the index finger. This was gradually dilated. Due to failure of complete cooperation on the part of the family physician, the stricture recurred two months later. It was again dilated and the patient kept under close observation. When last seen, one year and three months after operation, the stricture readily admitted the middle finger and the patient was quite comfortable.

**Case 2**—R. J. B., white male, age 41, was an inmate of the Philadelphia Hospital for Mental Diseases, suffering from schizophrenia. He was admitted to the Philadelphia General Hospital May 25, 1935, with a prolapse of the rectum in which palliative treatment had failed during the preceding several weeks. In 1932 he had had a prolapse which had been treated by linear cauterization.

*Operation*—May 28, 1935. Under gas anesthesia the patient's colon was thoroughly irrigated—and the anal sphincter stretched. A thick, stiff, rubber tube was inserted to just above the external sphincter and fixed in place with two silk sutures to the prolapsed rectum. A flexible rubber tube was then twisted about the mucocutaneous junction and fixed with two silk sutures. The prolapse was dressed with vaseline and dry gauze. Despite restraint on the night of operation, the rectal tube was found in bed with sutures.

torn out. An elastic ligature was reapplied on May 30, 1935. On June 6, 1935, the prolapse sloughed off, following a bowel movement, leaving a clean surface.

*Follow Up*—Examination one year later, April 1, 1936, revealed a normal rectum, without stricture and no evidence of recurrence.

**Case 3**—H. C., female, age 45, had had a prolapse of the rectum for the past ten years. Originally the prolapse occurred only when at stool, but it gradually began to occur more often and became larger. She had a laparotomy in 1931 to correct the condition, but the operation was a failure.

*Physical Examination* revealed an obese woman, apparently well except for a prolapse of the rectum, when straining. The prolapse did not include the entire thickness of the rectal wall but apparently only involved the mucosa. On straining the mucosa covering the anterior wall of the rectum appeared at the anus and gradually prolapsed until the entire circumference of the bowel was involved.

*Operation* February 19, 1936. Under gas anesthesia, a large rubber tube was placed in the rectum and the prolapsed mucous membrane pulled down as far as possible, it was then strangulated by a heavy rubber band. The mucous membrane was prevented from retracting by suturing it to the rubber tube. Ten days later the strangulated portion sloughed off, leaving a clean granulating surface.

*Follow Up*—Care has been given in the Proctoscopic Clinic, which consisted of weekly dilatations. Examination four months after operation showed a completely healed rectum with a thin membrane at the site of amputation. This readily admitted middle finger. The patient had no complaints.

**DISCUSSION**—In Case 1 two complications were encountered, namely, hemorrhage and stricture. The only suggestion that might be of value in avoiding hemorrhage is the fact that it followed manipulation of the strangulated portion of the rectum. Probably hemorrhage would be a less frequent complication if separation were allowed to occur absolutely spontaneously. One should be able to prevent the formation of stricture by close follow up care as shown in the last two cases. Case 2 was an ideal test as the patient was mentally unable to extend any cooperation whatsoever. In spite of this fact there has been no recurrence and result has been entirely satisfactory.

Naturally this procedure is not recommended in all cases of rectal prolapse. Especially in children, which comprise 70 per cent of all cases, more conservative measures should be given a trial. However, in certain cases it seems as if this method were a definite addition to a surgeon's armamentarium. Irreducible prolapse with infection of the prolapsed portion is the strongest indication for its use but as shown by the three cases reported herewith, this method can be used with advantage in prolapses which are less far advanced. The published reports show that there is no danger of recurrence whereas other operative procedures give an incidence of recurrence varying from 6 to 15 per cent. The danger of stricture is a real one, however, and must be guarded against by close follow up care in these patients. Wangenstein suggests the use of antigas serum prophylactically, which may be a worthwhile procedure.

#### SUMMARY

(1) Three cases of rectal prolapse are presented treated by the strangulation method by means of an elastic ligature.

- (2) Good end-results were obtained in all three
- (3) The danger of stricture as a complication is emphasized

## REFERENCES

- <sup>1</sup> Bakes, Jar Deutsche Ztschr f Chir , 54, 325, 1900
- <sup>2</sup> Bauer, Albert Ergebnisse der Chirurgie und Orthopadie Vieter Band, 573, 1912
- <sup>3</sup> Mikulicz Arch f klin Chir , 38, 74, 1889
- <sup>4</sup> Reid, Mont R Am Jour Surg , 20, 359, 1933
- <sup>5</sup> Wangenstein, Owen Minnesota Med , 17, 219, 1934
- <sup>6</sup> Weinlechner, Joseph Wien med Wchnschr , 33, 751, 1883
- <sup>7</sup> Weinlechner, Joseph Wien med Wchnschr , 36, 536, 1886



# TUMORS OF THE UTERUS \*

WITH SPECIAL REFERENCE TO FIBROIDS

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THE fibroid bearing woman is not, of necessity, a surgical entity. Eliminating those tumors which should be treated by roentgen therapy or radium, operation is not, and should not be, advised unless one or more of the conditions mentioned subsequently exists in the patient under consideration.

As I am now dealing with the surgical consideration of fibroids I eliminate in this contribution all reference to the use of radium or roentgen ray, although I admit the value of these agents in certain cases. Owing to the infrequent occasions on which we find fibroids have become sarcomatous or carcinoma is associated with fibroids, the malignant argument should not be used as a whip to force the patient to operation without explaining the low incidence of carcinoma in this condition. The possibility of malignant degeneration is never mentioned by me to my patients unless they bring up the argument. I then frankly tell them of the infrequency of fibroids degenerating into a malignancy. The arguments I do use in advising an operation are those covering anemia from the loss of blood, the possibility of irritation, degeneration and necrosis. I advise operation in all symptom bearing cases, those with multiple tumors, irrespective of size, and those with single tumors which are over the size of a three and one-half or four months' pregnancy.

I concede that the radical removal, subtotal or total hysterectomy, prevents conception. The same applies when radium or roentgen therapy is used. However, the operative procedure has the advantage over treatment by radium or roentgen ray, in that the patient is not thrown into a sudden, complete menopause. Roentgen therapy and radium destroy all function of the ovaries, whereas an operation always presents the opportunity to save one ovary or both if, on examination, either one or both presents a clinically healthy appearance. By retaining one or both ovaries together with the tube or tubes the manifestations of menopause will be held in check for a time and will not, therefore, be so acute.

Some of the symptoms that call for the operation argument are

- (1) Excessive bleeding, frequent or irregular bleeding, intermenstrual leakage or "shows"
- (2) Urinary frequency, nocturia and dysuria
- (3) Gastro-intestinal distress, chiefly observed following a fair sized meal, which is often due to the limited intra-abdominal space caused by the displacement of the growth
- (4) Pressure symptoms which include backache if it can be proved that

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the backache is not due to other sources such as osteo-arthritis, inflammation or other pathologic intra-abdominal sources, pelvic pain produced by pressure on the lumbar and sacral plexuses, edema of the extremities as seen in some of the large growths, the result of pressure upon the return circulation

(5) Recurring attacks of pain simulating peritonitis and perhaps due to friction between the tumor and the abdominal contents or the parietal peritoneum

(6) Rapidly growing tumors, which always convey the idea of degeneration, usually myxomatous, although they may be malignant

(7) Twisting of a pedicle in the pedunculated variety, which demands exploration before a positive diagnosis of twisted pedicle may or can be made

(8) Exceptional size in a symptom free growth, forcing the patient to come to the surgeon and solicit an operation, to check the remarks of neighbors and friends, especially if the patient is unmarried or widowed

(9) Cardiac changes with or without definite blood pressure increase

(10) Anemia and dyspnea

(11) Necrosis or sloughing

(12) Mental distress after the diagnosis of a tumor has been made

Myomectomy is always forcefully presented to the woman who desires a child, although I never permit a patient to leave the office before she fully understands that she must give her consent for the operation which is considered best for her when the uterus and its tenant or tenants are exposed

It is interesting to note that myomectomy is followed in many instances by the further involvement of the uterus with fibroids, usually within five to ten years of the time of the original operation. This involvement necessitates an hysterectomy. I recall an instance when a specimen removed by myomectomy was reported as being benign. Three years later a removal of the uterus and the adnexa was necessitated for a malignancy at the site of the myomectomy scar. There is no question in my mind but that a fibroid predicates more tumors in the body structure. This is easily demonstrable on section of the uterus as numerous small patches are seen in the walls which sooner or later may reach a size that may be easily palpable and which will require surgical intervention. Nevertheless, we naturally desire to save the uterus in a young woman who is anxious to bear a child. Myomectomy is in order, when possible, even with the likelihood of a second operation at a later date.

Carcinomatous degeneration of fibroid tumors has not been seen by me in over 1,700 operations. Sarcoma of the uterine tumor has been reported in several instances.

Carcinoma or sarcoma may involve the musculature in the immediate vicinity of the fibroid or fibroids. The operative treatment, admitting a small operative trauma to the surrounding structures, has many advantages over the institution of roentgen or radium therapy, especially in members of the working class. In other words, it is much more economical as to time. The operation and repair, in all cases healing by primary intention, allow a

patient to be discharged from the hospital on the fourteenth postoperative day with an early return to work, as a rule. Compare this with the drawn out period of radiation treatments, although more recently roentgen therapy is able to provide an earlier result.

The operation as performed by me is the Kelly, from above down, *etc.*, with a few modifications. After the vaginal canal has been thoroughly iodinated, we are careful to see that the iodine swab has entered the posterior fornix, a catheterization and dry abdominal shave are usually done while the patient is being anesthetized, 3½ per cent tincture of iodine is then applied to the abdomen, the application extending up to the xiphoid cartilage so that if stones are found in the gallbladder, on palpation, this organ may be removed, provided the patient's condition permits.

After the abdomen is opened, the uterus or the tumor is seized with a long volsella forceps or a coarscrew. Artery clamps are placed on the broad and round ligaments, one juxta-uterine, the other lateral. I then cut between them and follow down in this manner until the cervix is reached. The last pair of clamps grasps the uterine artery. The peritoneum and bladder are pushed down on the cervix by cutting transversely from the clamped side to the opposite side and the cervix is then cut through to the uterine artery of the opposite side. If care is taken this artery may be seen on the other side. With the cervix cut across the artery and broad ligament are then clamped from below upward and cut, proceeding upward in this manner until the broad and round ligaments have been entirely cut through. The cervical canal is then cauterized or caulked out.

In the subtotal operation a running catgut suture, beginning where the uterine artery has been tied, is then applied through the broad and round ligaments enclosing the clamp. As the suture reaches the end of the clamp bite the clamp is removed and the suture drawn and tied with the end of the uterine artery ligature. This method of suture is continued over the clamps until the entire broad ligament is sutured. The sutured broad and round ligaments are then attached to the cervical stump and the ligaments on the opposite side are then sutured in the same manner. The peritoneal toilet is completed by approximating the ligaments over the cervical stump together with the peritoneum associated with the bladder. I cannot too strongly advise thorough hemostasis of the round ligament, although the late Doctor Baldwin, of Columbus, Ohio, has stated that "the blood supply of this structure is of no importance." I have seen a hemorrhage within a few hours after an hysterectomy which required a transfusion and a reopening of the abdomen. The bleeding point was easily seen in the middle of the round ligament.

When doing a complete operation the method of procedure is the same up to the point where the uterus has been removed. The next step is the pushing of the peritoneum and the bladder down from the cervix and the vagina, so that a transverse incision may be made into the vaginal vault and the anterior lip of the cervix grasped with a pair of double-toothed volsella, then the

cervix is rotated on its transverse axis and is ablated from the vagina. After ablation the vaginal wall is sutured. This stops the major portion of the oozing. With the vault closed, we proceed with the broad and round ligament sutures as in the subtotal operation. Finally, the stumps are attached to the sutured vault and the peritoneal toilet completed.

It is my custom at the operation to perform a complete hysterectomy on every patient with a lacerated cervix. This is primarily because of the disagreeable leukorrhea, persistent in many patients in whom the cervix is retained, and, secondly, because of the possibility of malignant degeneration in the retained cervix. This malignancy occurrence is rated from 0.2 to 3 per cent of all retained cervixes although this percentage does not present to me a minimal possibility, as will be shown later. Based upon the malignancy argument I would advise the occasional operator to perform a subtotal hysterectomy with reaming out or cauterizing of the cervical canal.

I am in the habit of leaving the adnexa in a patient under 48 years of age, provided she is not in, or finished with, the menopause at the time of operation. Formerly I left the ovaries or an ovary, being careful to sacrifice the tubes for fear of a hydrosalpinx at a remote period. Now, if there is no visible gross lesion of either ovary or tube, great care is taken to retain these organs.

I am satisfied that in the past ten years, in my experience with this procedure of conservation, the menopause onset is delayed or not so profound as it was in the patients in whom I formerly sacrificed the tubes. Further, in follow-ups on these patients I do not have any secondary operations for cysts or similar growths which would cause me to change my procedure. This clinical feature may only be explained on the grounds of retained nerve and vessel supply when conservation of the tubes is practiced. Naturally, if the adnexa are obviously involved they are removed.

It is also my procedure to investigate carefully the gallbladder and to remove the appendix when present. The gallbladder is either removed if it contains stones, or the knowledge of the presence of stones is transmitted to some member of the patient's family with instructions as to future intervention.

While I am not strongly disposed to argue malignancy as a resultant of cholelithiasis I cannot but recall a patient, operated upon some years ago, on whom I had made a record at operation of three fairly large stones in the gallbladder. The gallbladder was not removed at the time of the hysterectomy on account of the patient's condition at the time. She was informed of the findings and of the advisability of an operation at a later date. I never saw her after her discharge until five years after the hysterectomy. She was then complaining that her gallstones had been working overtime for about three months and that she had a very tender lump in her right side. Upon examination it was first supposed that she had an acute cholecystitis, but when under anesthesia a definite nodular mass was readily felt the diagnosis

was changed to malignancy as a possibility. Abdominal section revealed an inoperable carcinoma of the gallbladder with hepatic metastases.

In an article published in *Surgical Clinics of North America*, April, 1928, I summarized my operative cases as follows. From January, 1917, to January, 1927, I had performed 495 subtotal hysterectomies with five deaths, 214 complete hysterectomies with three deaths or a total in the ten years of 709 operations with a mortality of eight. Previous to that period I had reported 334 hysterectomies with two deaths so that in a total of 1,042 hysterectomies with ten deaths the mortality was less than 1 per cent. Of these ten deaths three were operations following the use of radium or roentgen therapy.

From January 1, 1927, until January 1, 1936, a period of nine years, I have a record of 664 operations with 11 deaths, a mortality of 1.65 per cent. Of this number 320 were subtotal hysterectomies and the remaining 291 were complete hysterectomies. In this series there were 44 cases of cholecystitis in whom a cholecystectomy was performed in 39, none of whom died. In the other five cases stones were found in the gallbladder, but for various reasons it was not removed. Appendectomy was performed in 538 cases. There were a number of cases recorded from whom the appendix had been removed previous to the operation for fibroids.

My reason for operating upon the gallbladder in these cases is due to the fact that in several instances I have had to consider an acute cholecystitis in a postoperative convalescence. Therefore, when conditions are favorable I remove the gallbladder.

An appendix left after an operation upon the uterus has given many of us more surgical occupation and worry than it would have if it had been removed at the time of the primary uterine operation.

In these 664 patients, of the past nine years, carcinoma of the body of the uterus was found in 24 instances and carcinoma of the cervix was found four times. Sarcoma was found twice. A myomectomy was performed in 35 instances.

As I have stated before, a subtotal hysterectomy was performed in 320 instances. Carcinoma of the remaining cervix in these cases occurred but twice, none in the first two years, so that the percentage is less than two-thirds of 1 per cent. I admit that for various reasons all of our patients do not return to us. Some move away, some are discontented with the operator after his bill has or has not been paid, and then there have been one or two who have had an injury to the bladder or ureter and have not cared to return. Out of these 320 in whom the cervix has been retained, quite a few, although as I have stated no records have been kept, have returned complaining of a simple or foul leukorrhea. It is for this reason and not the malignancy incidence that I advocate the complete operation.

Of this series there were 574 patients who had been married, not all of whom had had children, and 90 patients who were single, several of whom had had a child or had had an abortion.

One of my patients, whom I am not including in my mortality incidence,

had an acute tuberculosis together with a fair grade of diabetes for which she had been taking insulin for several years. On examination the cervix was found to be the site of a malignancy. A complete hysterectomy was performed. Several weeks later a tubercular meningitis developed, from which she died.

Pregnancy was found in 14 instances, one of which was extra-uterine. This may seem to convey the idea that our diagnostic ability was at fault or that gullibility is, or was, a great factor. Several of these pregnancies were found in myomectomy cases. One case I have particularly in mind was a woman with an evident four and one-half months' pregnancy in addition to three subserous fibroids, each as large as a cocoanut and each readily removed. The patient went on to full term with complete recovery after myomectomy of the three fibroids. Another of my patients had denied all possibility of pregnancy and insisted she had had a full menstrual flow within 18 days of her operation. Unfortunately my gullibility precluded an Aschheim-Zondek test. To add to my chagrin I operated upon this patient before a visiting group of the American Association of Obstetricians, Gynecologists and Abdominal Surgeons.

All of these pregnancy cases were operated upon for fibroids in excess of the size of the pregnancy, the latter condition being known or suspected in the majority of instances.

In one of my patients, an unmarried woman under forty, a carcinoma of the sigmoid was found after completing the toilet of the peritoneum and removing the walling-off pack. The abdomen was closed and reopened three weeks later, at which time a sigmoidectomy was performed.

My mortalities have included pneumonia, embolus, peritonitis (diagnosed by the pathologic department on autopsy, because a bit of bloody serum was found in the pelvis, but this was disputed by me), anemia and dehiscence of the wound. There was one patient who died because she said she would die and would not lend herself to treatment or cooperation. No cause was recorded as a result of the autopsy.

About five years ago I operated upon a young woman, age 22, in a suburban town for multiple fibroids of the uterus and a pathologic appendix. A complete hysterectomy was performed, retaining both adnexa, and the specimen sent to the State laboratory. It was reported back as malignant leiomyoma of the uterus. This patient lived for almost four years after her operation. The pathologist at the Post-Graduate Hospital made a report on the specimen of extensive spindle cell sarcoma of the uterus.

OPERATIVE COMPLICATIONS.—In my operations upon the uterus during these past nine years I have found the following conditions added to, or associated with, the tumors of the uterus: carcinoma of an ovary or both ovaries was found in nine instances and in all these cases both adnexa were removed. A carcinoma of the stomach was found in one case for which a Pylor anastomosis was performed two weeks following a subtotal hysterectomy. Nephrectomy was necessitated in two instances, one for a carcinoma

and the other for an hydronephrosis. Carcinoma of the rectosigmoid was found in four instances, one with an implantation at the cervicocolporeal junction for which a sigmoidostomy was effected, a Mikulicz operation in another and a resection in the other two cases. Ten inches of the ileum were resected in another instance because of dense attachments due to carcinomatous invasion. Carcinoma of the rectum was found in one case but the patient died of pneumonia subsequent to the operation for fibroids. There were two cases of mastitis and one case of carcinoma of the breast, a simple excision being done in the first two instances and a complete amputation in the case of carcinoma. In the spring of 1934 I removed a tumor weighing 15 1/8 pounds from a bride of a few months who was at that time 32 years of age. A frozen section on the specimen sent to the pathologic laboratory was reported back as leiomyosarcoma, apparently slow growing. Four days later the final report from the laboratory was received, giving the diagnosis as leiomyoblastoma showing excessive growth energy. The pathologist added the note that the patient should be carefully observed for possible recurrence in the pelvis or metastasis to the lungs. She returned for a general check-up in January of this year, about 19 months from the time of her operation, and reported as being in fine condition. Examination at this time was absolutely negative as to any recurrence. She reported May 5 of this year that she was still in excellent health.

Leiomyoma was reported in 128, fibroma in 484 and adenomyoma in 13 instances in this series of 664 cases.

In one of my patients, upon whom a subtotal hysterectomy had been performed, I opened the sigmoid and bladder on account of dense attachments. The opening in the sigmoid healed promptly leaving a vesicocervicovaginal fistula which was repaired successfully after two attempts. The fistula admitted a very small bougie into the bladder through the cervical canal.

I have had another case of a vesicovaginal fistula following a complete hysterectomy. This was repaired during the eighth postoperative week.

Another of my patients had a tumor with an added pregnancy so that the mass was equal to about three and one-half months. She denied the associated pregnancy. A complete hysterectomy was done. She was in excellent condition until the eighth or ninth day following operation. During that time she had passed from 250 to 600 cc of urine at a time. On the eighth day the urine was blood tinged and on catheterization on the ninth day 1,500 cc of clear urine was obtained. From that day she has leaked a great amount of urine. It has not been possible to corral her for cystoscopy and operation.

As before stated, I have never found one patient in whom I had performed a second operation for a cystic ovary or for salpingitis in those patients in whom the adnexa have been saved. In the spring of 1935 one of our surgeons said he removed a cyst in the case of a very prominent woman whose records, both those of the hospital and my own, showed that a sub-

total hysterectomy and a bilateral oophorectomy had been effected at the time of her original operation. She was 63 years of age when I operated upon her. The question arises as to an aberrant ovary which had become cystic.

The majority of young women to whom operation has been advised have raised strong objections to the possibility of the development of corpulency after a hysterectomy, the development of a deep bass voice, the development of hair over the face and body and the loss of sexual desire. I have been able to convince these patients that all these fears are without foundation.

Let us now consider the retained cervix. I have never been enthusiastic about the retained cervix as a potential source of cancer, any more than I have been impressed with the statement that all lacerated cervixes are liable to malignancy. One of the most vicious carcinomas of the cervix that I have seen was found in the bride of a physician. She had been married but a few months and had not been pregnant. No instruments had ever been used on her. She had a history of unusual bleeding and was referred to me by her husband. The examination revealed a soft, fungating growth. A biopsy was taken and reported back by the pathologists as a highly malignant growth. Actual cautery of the cervix and body by the Byrnes' method was done, followed later on with a transabdominal removal. Extensive abdominal metastases followed with death occurring in less than nine months.

I accept the dictum that a badly lacerated or ulcerated cervix with everted lips is a case for repair, and is more liable to a malignant change than a nonlacerated cervix. Following along this argument I quote the following from an article by Dr. Lillian K. Farrar, published in the April, 1935, issue of *Surgery, Gynecology and Obstetrics*: "Total abdominal hysterectomy avoids the danger of leaving a diseased cervix or an unsuspected carcinoma in the cervix." In a most meticulous article Doctor Farrar has not quoted her percentage of malignancy in the retained cervix but cites the figures of Chrobak of the University Clinic of Vienna who reported three cases of cancer that had developed in the stumps of cervixes several years after a supravaginal hysterectomy had been performed. Masson at the Mayo Clinic reported 29 cases seen in five years. He did not state how many had been retained. "In the Woman's Hospital the incidence of carcinoma developing in the cervical stump one or more years after a supravaginal hysterectomy is 7 per cent of all patients who come to the clinic for treatment of carcinoma of the cervix." Hence the incidence of malignancy in the retained cervix must be small.

Dr. Edward H. Richardson, of Baltimore, in an article on "Total Versus Subtotal Hysterectomy," *The American Journal of Surgery*, June, 1935, states "I would unhesitatingly conclude that the occurrence of stump cancer is so rare as to be a negligible factor in this discussion. The average incidence subsequent to approximately 10,000 subtotal hysterectomies reported by a dozen different authors is a little less than 1 per cent." He further states "the practice of coring out the mucous membrane of the cervical canal



at the time of subtotal hysterectomy or destruction of it by heat, applied in one form or another, has been emphasized by some surgeons and adopted by a considerable number as a reliable safeguard against the subsequent development of stump cancer. But when it is recalled that more than 80 per cent of all cancers of the cervix originate from the squamous epithelium of the portiovaginalis, it becomes evident that this procedure has only a meager prophylactic value. On the other hand, the majority of stump cancers appearing within one year after subtotal hysterectomy are adenocarcinomata and since these are assumed to coexist at the time of the operation it becomes evident that the block of cored out cervical tissue possesses particular value for immediate biopsy by the frozen section technic. Two other points of practical importance appear to have been established through statistical studies which need to be emphasized because they are in conflict with prevailing surgical opinion: (1) that approximately 10 per cent of these stump cancers occur in women from 20 to 35 years of age, and (2) that over 20 per cent of these women have never been pregnant.

"The latter point serves to focus our attention sharply upon the possible rôle which chronic infections of the cervix play in the etiology of cancer, since a considerable proportion of stump cancers follow subtotal hysterectomies performed because of the late consequences of uterine and adnexal infections. Furthermore, it has been abundantly demonstrated that such infected cervixes are etiologically responsible for at least a small proportion of the cases of infection arthritis. Chronic leukorrhea, which is so prevalent as to be accorded but scant consideration by the average doctor, is the sign that points unmistakably to the existence of these lurking menaces. Consequently, the teaching of those who emphatically condemn subtotal hysterectomy in the presence of chronic infection of the cervix is unquestionably sound."

In an article by Dr. Erle Henriksen of the Department of Gynecology at Johns Hopkins Hospital, "Carcinoma of Cervix Uteri," *Archives of Surgery*, June, 1935, he states: "If the growth appears after a period of two years it is considered a new growth, with this rule the percentage of carcinoma in the stump is reduced to less than 0.2 per cent. The growth may be assumed to have been preexistent if it occurs within two years after the operation. This low percentage can be further reduced if, during the surgical removal of the uterus, the cervix is either cauterized or repaired as indicated. If the growth appears before two years it is considered to have been present at the time of the operation but to have been overlooked." He summarizes that 22 cases occurred in the cervical stump following subtotal hysterectomy but does not mention the number of subtotal hysterectomies performed, with an average lapse of five years.

#### SUMMARY

(1) That fibroids under three and one-half months' pregnancy size are benefited by the use of roentgen therapy or radium in many instances.

(2) That fibroids up to four months' size and larger, if nonsymptom bearing, may be kept under observation

(3) That the incidence of carcinoma of the left-in cervix is so small that a subtotal hysterectomy is acceptable in many patients

(4) That all lacerated cervixes with eversion of the lips, infection and ulceration should be removed. In other words, a complete hysterectomy should be performed to prevent the possibility of a carcinoma, small as the percentage may be, and to prevent the nuisance and undesirability of an obnoxious leukorrhea

(5) That patients should be impressed with the fact that fibroids do not degenerate into carcinoma or sarcoma, thereby allaying their fears and reducing the cancer phobia. Cancer argument should not be used as a whip to operation

(6) That the carcinomata of the left-in cervix after the first year are primary carcinoma

(7) That carcinomata of the left-in cervix in the first year are, in all probability, carcinomata which have been overlooked at the time of operation

# PRIMARY CARCINOMA OF THE MALE URETHRA

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ALTHOUGH it is a well recognized fact that the urogenital tract does show a striking inherent predisposition to the development of neoplastic growths, the one portion which does not manifest this peculiar tendency, except in rare instances, is the urethra. The authors are cognizant of the intrinsic value of the report of such a rare pathologic lesion as primary carcinoma of the male urethra but feel that there is further justification for this additional contribution to the literature which is fast becoming replete with similar case reports in the fact that further emphasis should be placed upon the early diagnosis and prompt treatment of this disease.

**Case Report**—H S, age 66, married, white, male, Jewish, tailor. Admitted to Sinai Hospital September 21, 1932, complaining of pain in the penis, an urethral discharge and swelling in the scrotum.

The patient had always been in good health until onset of present illness two years ago. He gave no history of gonorrhea or syphilis. He first consulted a physician about the middle of June, 1932, because of an urethral discharge and pain on urination. At that time there were no other urinary symptoms. He was treated at another clinic where he received anterior urethral irrigations of potassium permanganate and "several" dilatations for "urethral strictures." A large right hydrocele, the size of a grapefruit, was tapped.

He was admitted to the Genito-Urinary Clinic of the Sinai Hospital August 12, 1932, complaining of pain and difficulty in voiding, burning and urethral discharge. Smears of the urethral discharge showed many pus cells and small bacilli. Examination with an olivary bougie and filiform and followers revealed a stricture of the anterior urethra 3 cm from the external meatus and another stricture in the membranous urethra.

On September 20, 1932, complaining of pain on urination, pain in the penis, discharge of blood and pus from the urethra, and fever, he was admitted to the hospital. There were no symptoms or complaints referable to the cardiac, pulmonary, gastrointestinal or neuromuscular systems other than a loss of strength and weight.

**Physical Examination**—The positive findings were limited to the inguinal, genital and rectal examinations. There were two large nodes about the size of hazel nuts present in the left inguinal region near the external ring and several small nodes, each of the size of a pea, in the right inguinal region. No herniae were present. The right side of the scrotum was enlarged to the size of a grapefruit due to the presence of an hydrocele of the tunica vaginalis of the right testicle. On rectal examination, the prostate was found to be enlarged (first degree), soft and elastic in consistency and globular in form.

The penis appeared to be of normal length but was deviated to the right. At the external meatus there were two openings, the upper was a false opening, the lower, situated immediately underneath, was smaller and represented the urethral meatus. A blood tinged purulent discharge was present. When the discharge was wiped away, a small piece of granulation tissue was seen protruding from the external meatus. For a distance of 7 cm from the external meatus, the penis including the glans and the

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corpora cavernosa appeared to be enlarged and annular in shape. At the point of greatest swelling, which was 2 cm behind the coronal margin, the penis measured 9 cm in circumference. The skin was tense and reddened. The entire area was tender



FIG 1—Photomicrograph of necrotic tissue removed from corpora at the first operation. Marked inflammatory and necrotic changes are readily detected. In the center of the necrotic area, one can detect atypical cells the actual morphology of which is difficult to determine under low magnification ( $\times 55$ )



FIG 2—Photomicrograph showing a higher magnification of the atypical cells noted in Fig 1. The cells appeared to be of epithelial origin and possessed unusual mitotic figures. These cells are undoubtedly carcinoma cells. The true nature of these cells was not established at the initial study but was recognized only on reexamination of these sections after the diagnosis of transitional cell carcinoma was made from sections of tissue removed at subsequent operation ( $\times 150$ )

and palpation resulted in an increased sanguineous discharge from the external meatus. The corpora cavernosa in this area had a hard, indurated consistency, irregular outline and were tender. In the left corpus cavernosum, there was a pea size area which was

firmer than the rest. A small irregular firm nodule of tissue was palpable in the spongy urethra about 4 cm from the external meatus.

Attempts to pass a No 16 olivary bougie beyond the fossa navicularis were unsuccessful. A filiform passed down the urethra for a distance of 4.5 cm and encountered an impassable obstruction which was not overcome with the aid of several small filiforms. Instrumentation of the urethra was extremely painful. Roentgenograms of the genito-urinary tract including the penis were negative. A tentative diagnosis was made of (1) urethral stricture with cavernositis and peri-urethral abscess, (2) carcinoma of the urethra, and (3) tuberculosis of the urethra.

*Course in the Hospital*—Hot compresses were applied to the affected area for ten days resulting in some diminution of the pain and frequency of urination. The patient's general condition had improved so much that on October 4, 1932, an exploration of the affected area was performed under gas.

Dense inflammatory adhesions about the urethra were severed and the urethra isolated. A



FIG 3—Photomicrograph showing typical transitional cell carcinoma ( $\times 55$ )

## CARCINOMA OF THE URETHRA

probe was passed into the urethra from the external meatus and emerged from the urethra at a point where there appeared to be an abscess connecting with the left corpus cavernosum. An incision, 3 cm long, was made into each corpora and a necrotic cheesy material evacuated. The cavities in each corpora were opened widely and through-and-through drainage with iodoform gauze was established. Some of the necrotic material and tissue from the corpora was sent to the laboratory for histologic study. From the operative findings, it was felt that we were dealing with an abscess of both corpora cavernosa secondary to an urethral stricture.

The pathologic report of necrotic tissue removed from the corpora indicated the



FIG 4—Drawing of specimen removed at operation. The dorsal surface of the penis with the flap of skin extending up on to the abdominal area can be readily seen. The shrunk and shriveled appearance of the penis is due to the extensive destructive process and the scars of repeated operations. The subcutaneous tissue of the lower third of the abdomen and the nodes of both inguinal and femoral regions have been removed en masse. The checkered areas indicate the location of groups of necrotic and abscessed nodes in both inguinal areas. The insert shows the ventral surface of the penis. The urethra has been opened to show the marked destruction involving the anterior portion of the penile urethra and both corpora cavernosa. The urethra above the involved area has a normal appearance and is slightly dilated.

presence of chronic inflammatory process with marked tissue destruction (Fig 1). There were several cellular areas, the actual morphology of which was difficult to ascertain owing to the marked inflammation and necrotic changes. Several of the cells appeared to be of epithelial origin and possessed unusual mitotic figures (Fig 2). In one section, too poorly stained for photographic reproduction, the cells had a papillomatous arrangement with marked proliferation and regular division. There was a diffuse polymorphonuclear exudate throughout this section. The pathologic diagnosis was infected papilloma of the urethra.

In view of the fact that the patient was having great difficulty in voiding and

showed signs of urinary extravasation about the penile urethra, a suprapubic cystostomy was performed October 28, 1932, under spinal anesthesia in order to divert the urinary stream. The swelling and induration around the spongy urethra and corpora cavernosa persisted. The tissues in this area were necrotic and infiltrated down to the penoscrotal junction. The external meatus was closed off by inflammatory tissue. On November 29, 1932, under gas anesthesia multiple incisions were made in the penis to establish ample drainage and to remove the necrotic tissue. Several pieces of tissue were removed for pathologic study and were reported as a transitional cell epithelioma of the urethra (Fig 3).

On December 27, 1932, a radical resection of the penis and lymphatic bearing area was performed under spinal anesthesia (Fig 4) according to the method of Young

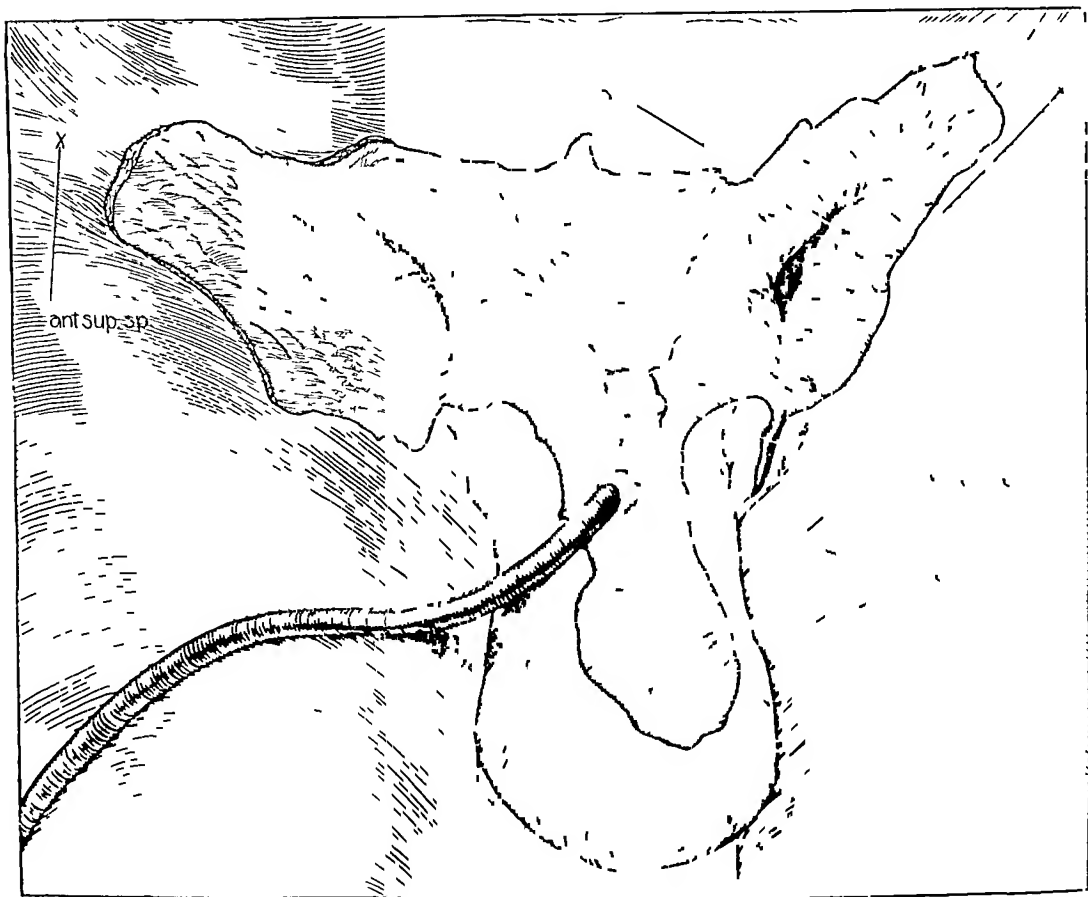


FIG 5—Drawing made three weeks after radical operation showing the breaking down of the abdominal portion of the wound and the left inguinal area.

A "bottle" operation was performed on the right side to cure the left hydrocele. The tumor had apparently infiltrated and totally occluded the anterior urethra particularly at the external meatus.

Following this operation, the patient seemed to do well. The remaining corpora, scrotum, right inguinal regions healed per primum. The abdominal area, near the midline, and the left femoral area broke down (Fig 5). On January 16 and January 25, 1933, pinch grafts taken from the left thigh were applied to the granulating areas with good results. The left inguinal and femoral areas continued to break down and produced a large crater-like sloughing area. This was treated with dry heat, hot compresses, ultraviolet light and roentgen radiation (four treatments—half erythema doses) with little improvement. The patient also developed an abscess in the subcutaneous tissue about the right hip which was incised and drained February 16, 1933.

The patient appeared to be fairly comfortable for about two months following the radical operation and then became progressively weaker. He developed a terminal bronchopneumonia and died May 17, 1933, which was approximately eight months after admission to the hospital and five months after the radical operation.

*Incidence*—The first case of carcinoma of the urethra was reported by Thiaudiere<sup>50</sup> in 1834, but as Kiwin<sup>23</sup> has pointed out, the diagnosis in this case was by no means clearly established. The first authentic case is that of Hutchinson,<sup>21</sup> in 1861. In 1907, Preiswerk<sup>39</sup> gathered 42 cases and in 1928 Kietschmei<sup>24</sup> reviewed the literature from the time of Preiswerk's article and collected 38 additional cases, making a total of 80 cases. In 1932, Kiwin gathered 19 cases from the literature in the nine years elapsing since the appearance of Kietschmei's contribution. The authors have found 12 additional cases, three of which (Tommasoli,<sup>52</sup> 1892, Sequena,<sup>45</sup> 1905, McCune,<sup>29</sup> 1927) were not included in Kiwin's report and the other nine (Geisler,<sup>14</sup> 1931, Mercier,<sup>31</sup> 1932, Beck,<sup>4</sup> 1932, Sokolov,<sup>47</sup> 1932, Boggon,<sup>5</sup> 1933, Lazarus,<sup>26</sup> 1934, Golonka,<sup>15</sup> 1934, Selvaggi,<sup>43</sup> 1934, and Astaldi,<sup>2</sup> 1935) were reported subsequent to Kiwin's publication, and add one personal case, thus bringing the total to 112 cases.

Kiwin showed that this neoplasm occurs with almost equal frequency in both sexes, or more specifically shows a slightly greater preponderance in the male. He collected 99 cases in the male and 96 cases in the female. Primary carcinoma of the male urethra is seen most frequently in patients past the age of 55 or more particularly in the sixth and seventh decades of life. In several instances, the condition has been observed in patients well under the so called cancer age. Paton's<sup>37</sup> patient was a youth of 18 and was the youngest case reported. Kroiss<sup>25</sup> observed an urethral carcinoma in a man of 91.

There appears to be no racial immunity against epithelioma of the urethra comparable to that existing in relation to epithelioma of the penis. Urethral carcinoma has been reported in a Mohammedan (a Hindoo) by Paton and has been observed in a Jew in the authors' case.

*Histopathology*—The normal epithelial lining of the male urethra varies in the different portions of this canal. The distal portion which is limited to the fossa navicularis is lined by squamous epithelium, the cavernous (or penile) portion by columnar epithelium and the prostatic urethra by transitional epithelium. In view of the variations in normal cellular morphology of the urethral mucosa, one may expect to find different cellular types of carcinoma. The histopathology of urethral carcinoma discloses three major types, namely, squamous cell epithelioma, papillary carcinoma, and a columnar cell variety of carcinoma. The most common type encountered is the squamous cell carcinoma with typical pearly body keratinization. This lesion occurred in 66 of Kietschmei's series of 80 cases.

Papillary carcinoma, as described by Slattock,<sup>46</sup> Englisch,<sup>12</sup> Kietschmei, and the columnar cell variety as described by Cabot<sup>7</sup> occur less frequently. Other rare types of urethral carcinoma are the transitional cell carcinoma

reported by Robb<sup>41</sup> and the adenocarcinoma reported by Olivier and Clunet<sup>35</sup> and Romano<sup>42</sup> Geisler<sup>14</sup> described a case of "very unique medullary" carcinoma which was extremely difficult to differentiate from sarcoma Robb<sup>41</sup> analyzed the histopathologic data in 76 cases collected from the literature and found that squamous cell carcinoma occurred in 73 per cent, adenocarcinoma (from Cowper's glands) 21.2 per cent, papillary carcinoma 3.5 per cent, columnar cell carcinoma 1.5 per cent, and transitional cell carcinoma 1.3 per cent

*Location*—A survey of the literature reveals the fact that any portion of the urethra may be the site of the carcinoma although certain portions show a greater predilection than others For clinical and pathologic purposes, it seems more practical to divide the urethra into two sections (a) penile, which includes the fossa navicularis and the cavernous portion, and (b) perineal, which consists of the bulbomembranous and prostatic portions and is frequently referred to as the deep urethra The importance of this classification lies not in the type of tumor concerned but rather in the practical adaptability of this classification to the course, extension, diagnosis and treatment of a tumor situated in either portion

Carcinoma occurs more frequently in the perineal than in the penile urethra inasmuch as the majority of the primary urethral neoplasms are situated in the bulbomembranous portion Preiswerk<sup>39</sup> found the cavernous and membranous areas were involved in 38 of 42 collected cases Rizzzi<sup>40</sup> noted that the cavernous urethra was involved in 52 per cent, the bulbous portion in 25 per cent, and the prostatic portion in 22 per cent In Diehl's<sup>10</sup> series of 61 cases, the distribution was as follows fossa navicularis, two cases, cavernous urethra, 26 cases, and membranous urethra, 33 cases Legueu<sup>27</sup> states that 63 per cent of urethral neoplasms are found in the perineal portion In the cases described by Menard,<sup>32</sup> Deveze,<sup>9</sup> Rizzzi,<sup>40</sup> Olivier and Clunet,<sup>35</sup> Tixon<sup>51</sup> and Kuwini,<sup>23</sup> the growth was seen protruding from the external meatus

*Pathology*—In its early stage, urethral carcinoma may present itself as a well localized growth which later manifests a tendency to spread slowly and insidiously and involve the adjacent urethral tissues In those cases where the tumor is situated in the fossa navicularis or in anterior portion of the penile urethra, the growth may appear at the external meatus and, on rare occasions, may involve the glans penis When the growth is located in the deeper portion of the penile urethra or in the bulbomembranous portion, the tumor may exhibit a tendency to spread and involve the remainder of the penile urethra as occurred in the authors' case but seldom appears to extend beyond the triangular ligament and invade the prostate Tumors occurring in the perineal or deep urethra may extend laterally and posteriorly to invade the perineum, triangular ligament, prostate or bladder Invasion of the corpora cavernosa takes place relatively early and produces a friable necrotic mass which soon becomes secondarily infected The malignant process may extend further and involve the skin of the penis or perineum with the formation of single or



multiple fistula and if infection supervenes, a periurethral abscess. The scrotal tissue and contents are seldom involved by the neoplastic process.

It is characteristic of urethral carcinoma to produce an obstruction of the urethral lumen either by circumferential constriction or by pedunculated masses. In some cases the partial or complete obstruction produced by the neoplasm is sufficient in itself to cause a rupture or tear in the urethral tissue which is followed by an extravasation of urine and eventually suppuration. The likelihood of urinary extravasation and infection of the peri-urethral tissues occurring is increased when the obstruction by the tumor is added to that produced by a preexisting stricture. The urinary extravasation usually occurs at or above the point where the friable and necrotic tumor tissue involves the urethra and produces the greatest obstruction. Since the urine in all patients with urethral carcinoma is infected with one or more different types of pathogenic bacteria, frank suppuration follows the extravasation and results in the appearance of an abscess in the corpora, periurethral tissues or perineum. Fistula formation is fairly common and may or may not be associated with urinary extravasation. In those cases where the tumor is located in the penile urethra, the opening of the fistula or fistulae is generally found on the under surface of the penis but may be found on any surface. In the case reported by Legueu, the opening was on the dorsum of the penis. When the tumor is situated in the perineal urethra and a fistula develops its opening is found in the perineum. The fact that these fistulae may form before the correct diagnosis is established is responsible for the doubt that exists in regard to whether the tumor is primary in the urethra or is the result of the malignant degeneration of the epithelial lining of the fistulous tract.

*Metastases*—Regional metastases by way of the lymphatics occur relatively late in the course of the disease and involve the inguinal or iliac nodes or both. Metastasis to the inguinal nodes occurs in practically every case and their involvement can usually be detected by careful palpation at the time of the initial examination. Selvaggi<sup>43</sup> calls attention to the fact that the inguinal adenopathy is often inflammatory. Metastatic involvement of the pelvic and lumbar nodes may occur as in the case reported by Montgomery<sup>33</sup> in which no other metastases were found at necropsy.

Metastases may involve structures or organs other than the inguinal and iliac nodes and reach these distant organs by a hematogenous route. In Allenbach's<sup>1</sup> case, the tumor not only metastasized to the iliac nodes about the left ureter but also to the lungs and liver. Metastatic nodules were found in the lungs of Guiard's<sup>17</sup> patient. Geisler<sup>14</sup> reported a case of medullary carcinoma of the polypoid type which was primary at the junction of the prostatic and membranous urethra and showed metastatic growths in the fossa navicularis, left epididymis and perineum.

*Etiology*—In a review of the cases reported, one is immediately impressed with the possible etiologic relationship between urethral carcinoma and other preexisting or coexisting diseased conditions. The following conditions bear

consideration as predisposing factors in the development of urethral carcinoma (a) gonorrhea and its complications, (b) nonspecific urethritis, (c) papilloma or polyp formation, (d) leukoplakia, (e) trauma or irritation of a mechanical or chemical nature, (f) sex perversion, (g) sexual contact and (h) Paget's disease of the penis

(a) The frequency with which a history of gonorrheal stricture is associated with urethral carcinoma further emphasizes this causal relationship. Beck<sup>3, 4</sup> attached much significance to this relationship and concluded that urethral carcinoma was a disease occurring in men past the age of 50 who have had a gonorrheal stricture. In Tanton's<sup>49</sup> series of 65 cases, 26 had had gonorrhea.

O'Neil<sup>36</sup> maintained that stricture was present in more than 50 per cent of the cases and Kirwin is of the opinion that there is a previous history of stricture in at least two-thirds of the cases. On the other hand, Kretschmer maintained that stricture should be regarded as an etiologic factor only so far as it might produce metaplasia or leukoplakia of the urethral mucosa. Imbert<sup>22</sup> has pointed out that the rarity of urethral cancer in the females is due to the fact that though gonorrhea frequently affects females, it is not so common with them as with men and that a gonorrheal stricture is an unusual finding in females. However, it is well to bear in mind that a large percentage of the cases give no history of gonorrhea or stricture formation and that a mere history of a gonorrheal infection, unsupported by an actual proof of the presence of a stricture, by no means establishes an immediate or direct etiologic relationship between gonorrheal urethritis and the carcinoma. It should be further emphasized that while urethral stricture following gonorrheal urethritis is common, malignant disease is rare. Robb reported a case of urethral carcinoma which had undoubtedly originated in a gonorrheal stricture. This patient also received 477 instrumentations during a series of 111 visits over a period of six years. This case emphasizes the rôle of chronic irritation from instruments in the production of urethral carcinoma in stricture cases. Wasserman, Gayet,<sup>13</sup> Platt and others have stressed the origin of carcinoma in the area of dilatation behind the stricture rather than in the stricture *per se*.

(b) A chronic urethritis of a nonspecific nature may likewise be responsible for producing an irritation or injury to the urethral tissues conducive to the development of a neoplasm. Scholl, Braasch and Long<sup>44</sup> reported a case in which the patient had an infectious urethritis in his youth with subsequent stricture formation which required dilatation over a period of 20 years. Guyon<sup>18</sup> described a case of urethral carcinoma in a patient who had suffered from a chronic urethritis with multiple perineal fistulae over a period of ten years. In some cases the urethral neoplasm has been found to be engrafted upon the site of a peri-urethral abscess.

(c) In some cases, a benign papilloma had been previously removed as noted in the cases reported by Grünfeld<sup>16</sup> and Kretschmer. In such cases the papilloma is usually in the anterior urethra close to the external meatus.

(d) A history of an antecedent leukoplakia has been mentioned in several cases. The authors have observed one case of leukoplakia of the anterior urethra in which carcinoma was suspected but a positive diagnosis could not be made as the patient refused operation.

(e) The role of trauma in the development of the urethral neoplasm has been strongly emphasized by several authors and by many is considered next in importance to gonorrhea and stricture formation as a predisposing factor. The type of injury may be classified as instrumental, accidental or chemical. Trauma of an accidental nature antedating an urethral carcinoma has been reported too frequently to be considered a mere incidental finding. Rizza found a history of trauma in 10 per cent of the cases. In the cases reported by Bierberbach and Peters,<sup>6</sup> Young,<sup>55</sup> Lower<sup>25</sup> and Hutchinson,<sup>21</sup> an injury to the perineum antedated the urethral neoplasm. Trauma in the form of chemical irritation as reported by Shattock,<sup>16</sup> Krietschmer and Culver<sup>8</sup> has been infrequently observed.

(f) Sex perversions may be another possible factor as indicated by the reports by Soubeyran<sup>18</sup> and of Olivier and Clunet. The introduction of foreign bodies into the urethra for masturbation purposes may result in injury to the urethral tissues as occurred in Soubeyran's patient who habitually inserted straws into the urethra.

(g) The role of sexual contact in the transmission of genital carcinoma in both sexes has not been definitely established. Edelman<sup>11</sup> has reported two cases of alleged contact infection from women with genital carcinoma.

(h) There are two cases (Tommasoli<sup>52</sup> and Sequena<sup>15</sup>) in literature, not included in any previous report in which a carcinoma of the urethra developed after a Piquet's disease (malignant papillary dermatitis) of the penis.

*Symptomatology*.—There is no symptom complex typical of carcinoma of the male urethra and for this reason the diagnosis is seldom made in the early stage. In an analysis of the symptomatology of the cases reported in the literature one is impressed with the fact that in the majority of the cases the patient states that he has enjoyed good health until the symptoms of urethral obstruction manifest themselves. The chief complaint and predominating symptom in practically every case is difficulty in urination which is strongly suggestive of the presence of a stricture or obstruction. The urinary difficulties resulting from obstruction may last for several months before local tumor formation is manifested or infection supervenes. Marked tenesmus and ardor urinae accompany the act of urination.

As the condition progresses, the pathologic process in the urethra spreads and produces changes in the size, shape and consistency of the penis. The presence or the development of a tumor mass is frequently the first sign that draws the attention of the physician or patient to the existence of a more serious lesion than a stricture. The penis swells in size and may assume a red hue or even appear to be cyanotic. A bloody cyst may develop on the under surface of the penis. Careful inspection and palpation will reveal one or more nodules along the course of the urethra or in the corpora

Edema may be present over the penis, scrotum and perineum and may be so severe as to simulate an extravasation of urine. The spread of the tumor into the erectile tissue of the corpora cavernosa may lead to a permanent partial erection or even to complete priapism. The narrowing or occlusion of the urethral lumen and the involvement of the corpora resulting from the spread of the tumor is responsible for erections and ejaculations becoming more and more painful until coitus becomes impossible.

Infection may supervene before the tumor becomes noticeable and as a result an urethral discharge may appear, which, if it has not been present or evident before, should direct attention to the possibility of an unrecognized lesion. The presence of a discharge may be one of the first signs to attract the patient's attention to his local condition. The discharge may contain gonococci as in the case reported by O'Neil, or it may be bloody as in Rizzi's and the authors' cases.

However, since the signs and symptoms of urethral carcinoma vary with the location of the tumor, it would appear more practical to consider the symptomatology as applied to the commonly accepted classification of this tumor into the following types: (a) penile, and (b) perineal. A brief consideration of the principal symptoms attending each of these two types is in order.

(a) Penile Tumor.—The outstanding symptoms of this type of tumor are (1) urinary difficulties resulting from obstruction, (2) the presence of a palpable tumor mass, and (3) urethral discharge and urethral bleeding. Pain, erections and priapism may be present.

(b) Perineal Tumor.—In this form, as in the penile type, symptoms of obstruction are present but are not quite so prominent. The most striking feature is the frequency of signs and symptoms of an infection superimposed upon those of obstruction. The most common finding is a peri-urethral abscess which serves as a successful disguise for the tumor. Urinary infiltration and extravasation are common findings. The final picture is one of fistula formation. Urethral bleeding, priapism, pain and urethral discharge are less frequently noted.

*Diagnosis*—The diagnosis of carcinoma of the urethra can be made with comparative ease when the tumor is situated in the penile urethra, especially those occurring in the fossa navicularis. Tumors situated in the perineal urethra offer the greatest diagnostic difficulties. We cannot urge too strongly the employment of early, and if necessary, repeated urethroscopic examination in all obscure cases of urinary disorders involving the lower urinary tract in which cystoscopy has failed to reveal the exact cause. This useful diagnostic procedure should not be postponed until a palpable tumor presents itself when it only serves to confirm the suspicions of the surgeon.

Mark<sup>30</sup> in 1908 and Imbert<sup>22</sup> in 1921 could find only three authentic cases in the literature where the carcinoma of the urethra was recognized by urethroscopy, *viz*, Grunfeld,<sup>16</sup> 1885, Beck,<sup>3</sup> 1890, and Oberlander,<sup>34</sup> 1893. However, in the recent literature, urethroscopy has been frequently employed by

many observers as a means of establishing or confirming the diagnosis. A piece of tumor should be removed through the urethroscope for microscopic examination in every case if possible.

*Differential Diagnosis*—As noted above, there should be no difficulty in establishing a correct diagnosis in those cases where the neoplasm is situated in the anterior or penile portion of the urethra because of the readiness with which a piece of the tumor can be removed for microscopic examination. Urethral neoplasms, particularly those situated in the perineal urethra, must be differentiated from the following conditions: (1) stricture, (2) periurethral abscess, (3) intra-urethral chancre, (4) tuberculosis, (5) carcinoma of the prostate, (6) carcinoma of Cowper's glands, and (7) benign tumors of the urethra.

The greatest diagnostic difficulties are encountered in differentiating urethral carcinoma from stricture. There are several diagnostic signs which are more characteristic of carcinoma than of stricture, namely, the occurrence of bleeding not associated with urination or erection, the presence of enlarged inguinal nodes of a metastatic nature, pain in the penis unassociated with urination, and loss of weight. A positive diagnosis can be made by urethroscopic examination and biopsy in cases of urethral neoplasm.

*Prognosis*—The prognosis in cases of urethral carcinoma is dependent upon the site of the lesion, the duration of the growth, and the extent of the metastases. In those cases where the neoplasm is situated in the anterior urethra near the external meatus and can be diagnosed early and is easily accessible to the necessary conservative or radical treatment, the prognosis is uniformly good. The prognosis is usually poor in cases of carcinoma of the perineal urethra where the tumor has spread extensively and infiltrated the surrounding tissue so that by the time the diagnosis is made operative treatment is impractical. The outlook is decidedly better in cases where the carcinoma is confined to the penile urethra as this type of case is amenable to operative treatment and has yielded the greatest percentage of cures. The occurrence or development of such complications as localized infections or abscess formation, extravasation, fistula and upper urinary tract disease which are secondary to the urethral obstruction naturally militate against a good result in these cases. Death in the operative or nonoperative case has usually been due to sepsis.

*Treatment*—The surgical treatment of urethral carcinoma has been far from satisfactory judging from the results reported in the early and even the recent articles on the subject which may be attributed to the fact that surgical intervention was employed too frequently in cases with hopeless infiltration and extensive infection. In many instances, the operation was undertaken primarily for symptomatic relief which is borne out by the fact that 79 per cent of the 72 cases collected by Watson<sup>51</sup> in 1929 were dead within six months after operation.

Radical operation is the procedure of choice in the treatment of urethral carcinoma and offers the best results from a curative standpoint. In view

of the fact that metastases occur late in the course of the disease, radical operation should be employed in every case excepting those advanced cases with severe infections and hopeless infiltration and metastases

We feel that it is best to remove the inguinal node bearing area in every case and thus prevent the possibility of a recurrence of the tumor in these nodes and at the same time remove every bit of potentially malignant tissue. In the very advanced cases with extensive lymph node metastases beyond the groin, radical operation is not indicated especially if the patient is in poor condition. In such cases, the operative treatment should be limited to simple amputation of the penis to remove the necrotic and infected tumor mass and to incision and drainage of abscess areas when present.

For those cases in which the tumor is confined to the anterior portion of the penile urethra and the surgeon is desirous of removing the affected organ together with the inguinal nodes, Young's operation (as described for carcinoma of the penis) appears to be the ideal procedure. In those cases where the tumor is situated in the distal third of the penile urethra or in the bulbomembranous portion of the perineal urethra, the operative removal of the entire penis including both corpora and practically the entire corpus spongiosum can best be performed by utilizing two incisions as described by Huggins and Curtis.<sup>20</sup>

Emasculation in cases of urethral carcinoma appears to be both unnecessary and undesirable as the malignant process seldom involves the scrotum or testes. Such mutilation adds immensely to the unhappiness of the patient as well as to his discomfort. Tumors confined to the anterior portion of the penile urethra and appearing at the external meatus can be treated by more conservative measures than radical operation. Electrocoagulation of the tumor area supplemented by the application of radium should give good results providing such treatment is instituted early before involvement of the inguinal lymph nodes has occurred. Kinnin reported a case in which the original lesion, situated close to the external meatus, was excised with bipolar cautery.

Heibst<sup>19</sup> in 1925 reported a case successfully treated by radium when fulguration failed to give results. However, the consensus of opinion is that in the late cases radium and deep roentgen therapy are of little value. Bieberbach and Peters<sup>6</sup> found that radium hastens necrosis of the malignant tissue producing a fatal toxemia and terminating life. Postoperative radiation of the perineum and inguinal node bearing area is indicated in those cases where the lymph nodes were not removed.

Scholl, Braasch and Long reported a case of urethral carcinoma in which the membranous urethra was excised through the perineum and later a portion of the saphenous vein was transplanted to fill in the defect. The patient also received 250 mg of radium in the tumor area and was reported alive and well four and one-half years later.

In 1929 Watson<sup>54</sup> reported two cases of urethral carcinoma treated successfully by radium therapy. In two of the three cases reported by Lower,<sup>28</sup>

a local resection of the urethra was performed with an end-to-end anastomosis and in both of these cases, stricture followed. There was no recurrence after eight years in one case and nine years in the others. The third case was an adenocarcinoma of the bulbomembranous urethra with extensive involvement of the urethra and metastases in the inguinal nodes. A radical operation was performed and the patient was reported free of recurrence at the end of two and one-half years. Kietschmer also reported a case in which there was no recurrence two years after radical operation.

#### CONCLUSIONS

(1) The authors report a case of carcinoma of the male urethra in a Jew and have collected 12 additional cases from the literature, thus making a total of 112 cases reported to date.

(2) Primary carcinoma of the male urethra occurs most frequently in patients past the age of 55, particularly in the sixth and seventh decades of life.

(3) There appears to be no racial or climatic immunity against carcinoma of the urethra comparable to that existing in relation to epithelioma of the penis inasmuch as cases of urethral carcinoma have been observed in Jews and Mohammedans and have been reported from all parts of the world.

(4) The three major types of urethral carcinoma are squamous cell epithelioma, papillary carcinoma and a columnar cell variety of carcinoma. Other less frequent forms are the transitional cell carcinoma, adenocarcinoma and medullary carcinoma. The most common type is the squamous cell carcinoma which occurs in more than 50 per cent of the cases.

(5) Primary carcinoma may occur in any portion of the urethra but is seen most frequently in the perineal urethra (bulbomembranous portion) than in the penile urethra.

(6) Primary urethral carcinoma may present itself as a well localized growth in the early stage and later manifest a tendency to spread slowly and involve the adjacent urethral and periurethral tissues with subsequent infection and development of a stricture, abscess, fistula or extravasation.

(7) Regional metastases by way of the lymphatics, involving the inguinal nodes particularly and less frequently the iliac nodes, are present in practically every case and occur relatively late in the course of the disease.

(8) There is no symptom complex absolutely typical of urethral carcinoma due to the fact that the symptoms vary with location of the growth and are noticeably affected by the presence of such complications as stricture, extravasation, abscess or fistula.

(9) Urethroscopic examination is the ideal method of establishing an early and correct diagnosis. A piece of tumor should be removed through the urethroscope for microscopic examination in every case if possible.

(10) The prognosis is dependent upon the duration of the growth, its location and the extent of metastases. Death in the operative or nonoperative case is usually due to urosepsis.

(11) Surgical treatment offers the greatest chance for a cure. Radical operation should be employed in every case excepting (a) in those advanced cases with severe infections, hopeless infiltration of metastases, and (b) in those cases with tumors confined to the anterior portion of the penile urethra, especially at the external meatus which may be treated by more conservative methods, i.e., electrocoagulation, and by radium.

## BIBLIOGRAPHY

- <sup>1</sup> Allenbach, E. Primäres urethral carcinoma mit priapismus ähnlichen folgen. *Deutsch Ztschr f Chir*, 138, 152-155, 1916
- <sup>2</sup> Astraldi, A. Primary Carcinoma of the Penile Urethra. *Urol and Cutan Rev*, 39, 20, January, 1935
- <sup>3</sup> Beck, M. A Case of Primary Squamous Carcinoma of the Bulbous Portion of the Urethra. *Internat Clin*, 2nd series, 2, 256, 1892
- <sup>4</sup> Beck, M. Primary Carcinoma in Male Urethra. *Ztschr f Urol*, 26, 401, 1932
- <sup>5</sup> Boggon, R. H. Carcinoma of the Male Urethra. *Brit Jour Surg*, 20, 640, April, 1933
- <sup>6</sup> Bierberbach, W. D., and Peters, N. N. Primary Epidermoid Carcinoma of the Male Posterior Urethra. *Jour Urol*, 22, 105, July, 1929
- <sup>7</sup> Cabot, A. T. Case of Cancer of the Urethra. *Boston Med and Surg Jour*, 133, 320-321, 1895
- <sup>8</sup> Culver, H., and Forster, N. K. Primary Carcinoma of the Urethra. *Surg, Gynec, and Obstet*, 36, 473, 1923
- <sup>9</sup> Deveze, L. Cancer primitif de l'uretre, operation de Bouisson, guérison. *Montpel med*, 20, 193, 1905
- <sup>10</sup> Diehl, K. Ueber das primäre urethralcarcinom des manne. *Virchows Arch f path Anat*, 256, 666, 1925
- <sup>11</sup> Edelman. Quoted by Selvaggi
- <sup>12</sup> Englisch, J. Das epitheliom der männlichen harnrohre. *Folia Urol*, 1, 38, 1907
- <sup>13</sup> Gayet. Quoted by Watson
- <sup>14</sup> Geisler, W. Extremely Undeveloped Carcinoma of Prostatic Portion of the Urethra with Metastases to the Fossa Navicularis. *Virchows Arch f path Anat*, 281, 88, 1931
- <sup>15</sup> Golonka, J. Primary Cancer of Male Urethra. *Polska Gaz Lek*, 13, 329, April 29, 1934
- <sup>16</sup> Grunfeld. Die endoscopie der harnrohre und blase. *Deutsch Chir*, 50, 193, 1881
- <sup>17</sup> Guiard. Quoted by Huggins and Curtis
- <sup>18</sup> Guyon, F. and Guiard, F. P. *Ann d mal d org gen-urin*, 8 and 9, 1883
- <sup>19</sup> Herbst. Quoted by Watson
- <sup>20</sup> Huggins, C. B., and Curtis, G. M. Cancer of the Male Urethra, with Technic of Penis Extirpation. *Surg, Gynec, and Obstet*, 48, 544, April, 1929
- <sup>21</sup> Hutchinson. Epithelial Cancer of the Mucous Membrane of the Urethra. *Trans Path Soc, London*, 13, 167, 1861-1862
- <sup>22</sup> Imbert, L. Neoplasmes de l'urethre. *Encyclopedie franç d'urol*, chap 13, Paris, O Doin, 5, 739, 1922
- <sup>23</sup> Kirwin, T. J. Primary Epithelioma of the Urethra. *Jour Urol*, 27, 539, May, 1932
- <sup>24</sup> Kretschmer, H. L. Primary Carcinoma of the Male Urethra. *Arch Surg*, 6, 830, 1923
- <sup>25</sup> Kroiss. Report of Case of Carcinoma of Urethra. *Wien klin Wchnschr*, 33, 326, 1920
- <sup>26</sup> Lazarus, J. A. Primary Carcinoma of the Male Urethra. *Jour Urol*, 31, 823, June, 1934



- <sup>27</sup> Legueu Cancer de l'uretre Med mod, 15, 313, 1904
- <sup>28</sup> Lower, W E Therapy of Malignant Growths of the Male Urethra, Clinical Report Trans Am Assn Genito-urin Surgeons, 24, 249, 1931
- <sup>29</sup> McCune Primary Carcinoma of the Bulb Atlantic Med Jour, 31, 182, December, 1927
- <sup>30</sup> Mark, E G New Growths of the Urethra Trans Am Urol Assn, 2, 13, 1908
- <sup>31</sup> Mercier, O A Case of Carcinoma of the Male Urethra Union med du Canada, 61, 336, February, 1932
- <sup>32</sup> Menard, P J Cancer primitif de l'urethre (meat et fosse naviculaire) Bull et mem Soc anat de Paris, 85, 394-396, 1910
- <sup>33</sup> Montgomery, W P Primary Epithelioma of the Bulbous Urethra Med chron, 1, 190-193, 1901
- <sup>34</sup> Oberlander, F M Beitrage zur lehre von primaren carcinoma urethrae Internat Centralbl f d Physiol u Path d Harn u Sex org, 4, 244-250, 1893
- <sup>35</sup> Olivier and Clunet Epithelioma primitif de l'urethre d'origine glandulaire Bull et mem Soc d'anat de Paris, 82, 735, 1907
- <sup>36</sup> O'Neil, R F Primary Carcinoma of the Male and Female Urethra Jour Urol, 5, 325, April, 1921
- <sup>37</sup> Paton, W C Case of Carcinoma of the Urethra in a Youth (Hindoo Boy, 18 Years of Age) Indian Med Gaz, 59, 461, September, 1924
- <sup>38</sup> Platt, J E Case of Primary Epithelioma of the Urethra Med Chron, 44, 94-98, 1906
- <sup>39</sup> Preiswerk, P Ueber das primare karzinom der mannlichen harnrohe mit Beitragen zur kasuistik Ztschr f Urol, 1, 273, 1907
- <sup>40</sup> Rizzi, W Ein fall von primarem carcinom der mannlichen urethra Ztschr f urol chir, 7, 1-11, 1921
- <sup>41</sup> Robb, J J Cancer of the Male Urethra Brit Jour Surg, 15, 605, April, 1928
- <sup>42</sup> Romano, G S'epithelioma primitivo dell-uretra maschile Reforma med, 28, 957-964, 1912
- <sup>43</sup> Selvaggi, G Cancer of Male Urethra Arch ital de urol, 11, 487, 1934
- <sup>44</sup> Scholl, A J, Braasch, W F, and Long Primary Tumors of the Urethra ANNALS OF SURGERY, 76, 246, 1922
- <sup>45</sup> Sequeira, J H Report of Case of Paget's Disease of Penis Brit Jour Dermatol, 17, 454, 1905
- <sup>46</sup> Shattock, S G An Example of Primary Carcinoma of the Male Urethra Trans Path Soc London, 58, 199, 1906
- <sup>47</sup> Sokolov, M Primary Carcinoma of Male Urethra Sov Klin, 18, 265, 1932
- <sup>48</sup> Soubeyran, P Epithelioma primitif de la portion penienne de l'urethre Bull et mem Soc anat de Paris, 77, 643, 1902
- <sup>49</sup> Tanton, J L'epitheliome primitif de l'urethre chez l'homme et chez la femme Revue generale Gaz de hôp, Paris, 83, 1251, 1910
- <sup>50</sup> Thiaudiere, P D Nouvelle espee de retrecissement de l'uretre, nouveau procede operatoire Bull gen de therap, 7, 240, 1834
- <sup>51</sup> Tison, Y Paris thesis, 1907
- <sup>52</sup> Tommasoli, P Contributo allo studio dell'epithelioma epidemico, (epithelioma verrucoso abortivo malattia di Paget della verga) Giorn d mal ven, 28, 542-577, 1898
- <sup>53</sup> Wasserman, M Epithelioma primitif de l'urethre Paris thesis, 1895
- <sup>54</sup> Watson, E M Cancer of the Male Urethra Jour Urol, 21, 217, February, 1929
- <sup>55</sup> Young, H H Practice of Urology Saunders Co, 2, Philadelphia, 1926

# SEVERED TENDONS AND NERVES OF THE HAND AND FOREARM

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TWO HUNDRED NINETY severed tendons and 26 severed nerves of the wrist and hand were treated by the Second Surgical Division of St Vincent's Hospital during the ten year period 1924 to 1934, on the service of the late Dr George David Stewart and his successor, Dr Raymond P Sullivan. The severed tendons occurred in 102 patients, while the severed nerves were found in 22 patients, 11 of them having both tendons and nerves severed. In all there were 113 patients injured.

The salient facts derived from this analysis of injuries to the upper extremity are as follows: That the nature of the weapon inflicting the injury bears a predisposing influence on both the site and the severity of the laceration, that infections in the wounds are not uncommon and may have serious sequelae, that these injuries occur usually in males and rarely in females, that there is no predilection for either arm to be involved, and that the section of the city within which the injury occurs bears a direct influence on the type of the weapons or implements causing the trauma.

*Causes*—The type of the weapon inflicting the injury has, by its very nature, an influence on the exact site, the severity and the ultimate outcome of the injury. The nature of the weapons varied in different sections of the

TABLE I  
NATURE OF AGENT CAUSING INJURY

Dorsum of Hand and Fingers	<div> 16 of 33 Known Causes Were Compensation Injuries  10 Cases from Broken Glasses or Bottles  4 " " Breaking Windows </div>
Palm of Hand and Fingers	<div> 20 of 35 Known Causes Due to Broken Glass  (16 Broken Bottles and Glasses—4 Breaking Windows)  6 Cases Due to Compensation Injuries </div>
Volar Surface of Wrist	<div> 22 of 29 Causes Due to Broken Glass  (16 Broken Windows—6 Broken Bottles or Glasses)  5 Cases Due to Compensation Injuries  (Caused by Falling Glass or Steel) </div>
Dorsal Surface of Wrist	The 2 Known Causes were Stabbings
27 of 99 known causes were due to compensation injuries 68% of cases resulted from stabbings (St Vincent's Hospital) At Harlem Hospital the percentage is about 80-90%	

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# SEVERED TENDONS AND NERVES

city (Table I), depending on the character of the industry and the racial traits of the inhabitants within a hospital's territory

At St Vincent's Hospital, situated in the Greenwich Village section of the city and serving a large industrial and commercial area, the most frequent tendon trauma (54 per cent) is inflicted by broken glass from windows, bottles and drinking vessels, while the next most frequent cause is compensation injuries (29 per cent), inflicted by printing presses, circular saws and other forms of factory machinery. The third cause, in order of frequency at this hospital, and comprising less than 7 per cent of the known causes, is stab wounds. In contrast to this last percentage in this section of the city, we have that of Harlem Hospital, where 80 to 90 per cent of all tendon lacerations are the result of stabbings.

Stab wounds are rarely inflicted on the palm of the hand, as the defendant is usually loth to grasp the sharp blade of the weapon that is thrust at him but instead endeavors to bat the blade away with his forearm. As a result about 75 per cent of these wounds are found at the wrist or on the dorsum of the hand (Table II)

TABLE II  
LOCATION OF INJURIES

Weapons	Volar Surface Wrist	Dorsal Surface Wrist	Palm Hand and Fingers	Dorsum Hand and Fingers
Glass (52 Cases)				
24 Windows	16	0	4	4
28 Glass Bottles	6	0	16	10
Stab Wounds (7 Cases)	1	2	2	2
Suicide Attempt (1 Case)	1 Razor	0	0	0
Miscellaneous Acci- dents (8 Cases)	0	0	7 { 1 Electric Fan 1 Organ Fan 1 Faucet 1 Razor 3 Knives	1 Playing Baseball
Compensative In- juries (27 Cases)	4 Falling Glass or Steel 1 Machine  (3 left 2 right)	0	6 { 3 Saws 1 Press 1 Knife 1 Sheet Iron  (3 left 3 right)	16 { 5 Machines 2 Saws 2 Gears 2 Presses 1 Knife 4 Falls on Glass or Can (8 left 8 right)
Totals (All Causes Not Reported)	29	2	35	33

Compensation injuries occur most frequently on the dorsum of the hand. These injuries are frequently jagged or crushing wounds which cause considerable maceration of tissue and are difficult to repair.

Broken windows usually severed the tendons at the level of the wrist, while broken bottles and glasses usually traumatized the tendons in the palm of the hand and fingers.

Numerous miscellaneous accidental causes were recorded, such as those caused by porcelain faucets, electric fans, organ fans, razors and kitchen knives, as well as one suicide attempt.

*Side and Sex Incidence and Site of Laceration*—Injuries were equally distributed between both limbs. Ninety-five of the 102 patients with tendon injuries were males (Table III). All injuries to females were slight. In-

TABLE III

## SEX AND SIDE INCIDENCE

Tendons (102 Cases)	95 Males	Right Hand	49
		Left Hand	47
		1 Case Bilateral	
	7 Females	Right Hand	2
		Left Hand	5
		(All Slight Injuries—No Severe Wounds)	

Neither compensation injuries, broken glass nor broken windows had a predisposition to injure any one side of the body.

Injuries at the wrist usually involved four or more tendons and one out of every two of these lacerations severed one or more nerves (Table IV).

TABLE IV

## SITE OF 109 WOUNDS IN 102 CASES OF TENDON LACERATION

Flexor surface	77	(70.7%)
Extensor surface	32	(29.3%)
<hr/>		
32%	of all lacerations were at the wrist	
68%	" " " " in hand or fingers	
17.5%	" " " " the hand	
50.5%	" " " " " fingers	
<hr/>		
40%	of all flexor lacerations were at the wrist	
60%	" " " " " in hand or fingers	
15.5%	" " " " " the palm of hand	
44.5%	" " " " " digits (palm)	
<hr/>		
12.5%	of all extensor lacerations were at the wrist	
87.5%	" " " " " in the hand or fingers	
21.8%	" " " " " on the dorsum of the hand	
65.7%	" " " " " in the fingers (dorsum)	

Fifty per cent of the lacerations were in the fingers and 32 per cent at the wrist, 71 per cent were on the flexor surface and 29 per cent were on the extensor surface. Our records show a preponderance of the injuries occur-

ring in three definite sites In their order of frequency they are (1) the palmar surface of the proximal phalanges, (2) the volar aspect of the wrist, and (3) the palm of the hand Two hundred twenty-two were digital tendons and 68 wrist tendons (Table V and Fig 1)

TABLE V

SITE OF 109 LACERATIONS IN 102 CASES OF TENDON INJURY

	Flexor Surface			Extensor Surface			Totals		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
Wrist	14	17	31	3	1	4	17	18	35
Hand	6	6	12	3	4	7	9	10	19
Digit I	5	4	9	2	3	5	7	7	14
Digit II	1	5	6	5	1	6	6	6	12
Digit III	5	5	10	1	3	4	6	8	14
Digit IV	2	3	5	2	2	4	4	5	9
Digit V	3	1	4	0	2	2	3	3	6
Totals	36	41	77	16	16	32	52	57	109

*Time of Repair* —Every effort should be made to see and repair these cases at the earliest possible moment, for a primary repair is of great economic value to the patient, and the ultimate functional result following a

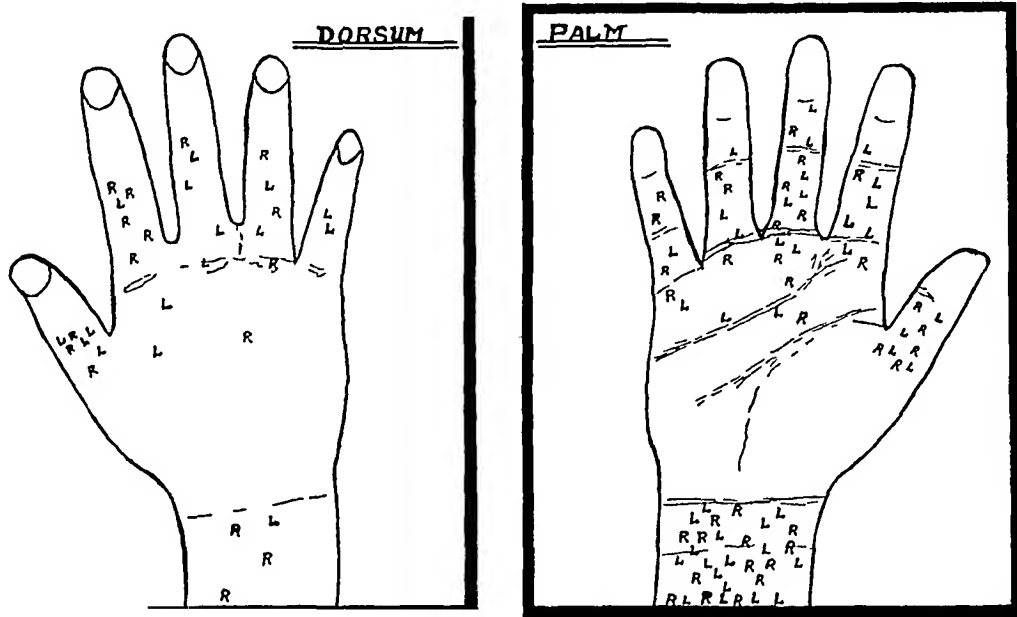


FIG 1—Graphic representation of site of injury in cases of tendon laceration R indicates right hand L indicates left hand

primary repair is far better than after a long delayed secondary repair has permitted the occurrence of atrophy and scar tissue formation

It is now an accepted practice and rule not to operate for primary repair of tendon injury unless the patient could be brought to the operating room within a certain limited number of hours as measured from the time the trauma was inflicted Injuries to the palm of the hand and palmar surface of the digits, all of which are supplied with tendon sheaths, must be repaired before two to three hours have elapsed Injuries to the volar surface of the

wrist must not be sutured any later than four hours after injury. Deep lacerations of the dorsum of the wrist must be operated upon within six hours, while a somewhat longer period of time may be allowed to elapse before repairing severed tendons on the dorsum of the hand and fingers where there are no true tendon sheaths. However, recently the policy of some has become even more conservative, and it is advocated by some never to do a primary repair of the flexor tendons of the palm of the hand but to wait

TABLE VI  
ANALYSIS OF 290 SEVERED TENDONS

222	Were Severed	Digital Tendons	76.5%
68	"	Wrist	23.5%
158	"	Digital Flexors	54.5% { 44.4% (Right) 55.6% (Left)
64	"	Digital Extensors	22% { 51.5% (Right) 48.5% (Left)
135	"	Tendons in Right Limb	46.6%
155	"	" " Left "	53.4%

	Flexors			Extensors			Totals		
	Right	Left	Total	Right	Left	Total	Right	Left	Total
Wrist	28	30	58	4	6	10	32	36	68
Digit I	7	9	16	6	10	16	13	19	32
Digit II	9	27	36	14	7	21	23	34	57
Digit III	19	25	44	4	6	10	23	31	54
Digit IV	15	15	30	5	4	9	20	19	39
Digit V	20	12	32	4	4	8	24	16	40
Totals	98	118	216	37	37	74	135	155	290
Digital Tendons	70	88	158	33	31	64	103	119	222

and do only secondary repairs. To this extreme policy we do not subscribe because of the protraction of the disability, which, in our opinion, is unwarranted if the necessary precautions are taken to prevent infection when performing a primary repair.

*Operations*—Twelve cases were not operated upon for various reasons, and 12 had secondary repairs, while 78 had primary repairs, thus leaving a net total of 265 tendons which were repaired at 90 operations (Table VII).

TABLE VII  
OPERATIONS FOR TENORRHAPHY

Total Cases	102	Total Tendons	290
Cases Not Repaired	12	Tendons Not Repaired	25
Cases Repaired	90	Tendons Repaired	265
199 Flexor and 66 Extensor Tendons Sutured			
Primary Repair in		78 Cases	
Secondary Repair in		12 Cases	
12 Cases Infected		13 1/3% Percentage of Infection	

No Deaths

The number of tendons repaired at any one operation varied between one and 14, depending on the site and severity of the laceration. The more extensive injuries often try the patience of the surgeon, as in a few instances they necessitated almost four hours to accomplish a meticulous repair of the damage done.

*Incidence of Infections*—Infection is the greatest danger associated with tendon injury, and if the surgeon does not believe he can thoroughly disinfect the wound and prevent the dissemination of the bacteria into the fertile soil of the surrounding soft parts while exploring the tissues for the retracted ends of the tendons, and unless he has seen the case sufficiently early, he should not attempt to perform a primary repair. These cases should never be drained, for if drainage is necessary the attempt at repair should not be made. The insertion of drains will jeopardize the functional result and will mitigate against that which is most desired, namely, the healing of the wound by primary intention. If the danger of infection is great, then the wound should be allowed to heal and no attempt at a secondary repair should be attempted for at least four to six months. The danger of virulent bacteria lying dormant in the soft tissues is as true in this type of case as it is in the open bone reduction after a compound fracture, when no surgeon would attempt the correction of the deformity for at least six months after the compounding wound was entirely healed.

Analysis of the 90 cases which were repaired showed that 12 cases became infected subsequently, thus creating a rate of infection of 13.33 per cent. In seeking after the cause or causes of this complication, every phase of the situation was investigated and it was found that seven of the 12 infected wounds were inflicted at, or immediately above, the flexor surface of the wrist, that three were on the flexor surface of the middle or proximal phalanges and two were on the dorsum of the hand, thus showing a marked tendency for the flexor tendons, especially at the wrist. The wounds in two patients were the result of stabbings, one man was injured at a machine, eight were incapacitated by broken glass or windows. The suture material in 11 of the 12 cases was chromic catgut and in the remaining case black silk was used. To emphasize further the disaster of infection in this type of case, it is significant to note that five of the seven known poor end-results in this whole series of cases were infected (Table VIII). The devastating effect of infections in wounds of sutured tendons is the death of the tendon due to the impaired blood supply and its subsequent sloughing out, leaving that part of the limb, which it had mobilized, completely incapacitated. Extensive infections about the wrist and palm of the hand may destroy all the tendons and cause the patient to be afflicted for the remainder of his life with a claw hand.

Tendon surgery has been too lightly regarded by many surgeons in the past. The custom of discharging a patient from the ward within a few days after operation is unfortunate, for on several occasions although the wound

was apparently clean on discharge from the ward, the patient returned to the Outpatient Department with a suppurating wound

TABLE VIII

## INCIDENCE OF INFECTIONS

12 Infections in 90 Primary Repair Operations	13 $\frac{1}{3}$ %
11 " " 79 Repaired with Chromic Catgut	14%
1 Infection in 11 " " Black Silk	9%
22 $\frac{1}{2}$ % Infections in Wound of Volar Aspect of Wrist	(7 of 31)
28 $\frac{1}{2}$ % " " " " Dorsum of Hand	(2 of 7)
8 $\frac{4}{5}$ % " " " " Palm of Hand and Fingers (Area of the Bursae)	(3 of 34)

Cause 8 Broken Glass or Windows, 2 Stabbings, 1 Machine, 1 Unknown

End-Results 5 of 6 known results were poor and 1 good 2 developed claw hands

*Surgical Repair of Severed Tendons*—In repairing severed nerves and tendons great care, perfect surgical technic and excellent surgical judgment are required. As regards the surgical procedure and technic, there is no need to elaborate at length but it would be well to stress a few important points.

(1) On admission the wound should be treated with an antiseptic and a sterile dressing applied. A temporary splint should then be fitted so as to hold the hand in a corrected position, with the injured tendons relaxed.

(2) Scrub the adjacent skin with soap and water. This is usually best done after the patient is anesthetized. Take care not to wash any further contamination into the wound. The washing of the skin should be done by the surgeon himself. If danger of additional contamination of the wound exists, it is more expedient to omit any scrubbing of the skin than to chance additional infection. Asepsis is all important.

(3) Paint the skin with iodine, picric acid or any other suitable disinfectant and swab the open wound with the same solution or 70 per cent alcohol. Swab the wound several times during the operation with iodine. I have made it a practice to pour a cup of iodine into the wound, and to this I attribute the absence of a single infection in any of my personal cases.

(4) A debridement of all the skin edges should be done.

(5) Do not crush your skin edges, as primary healing is desired.

(6) A tourniquet (or blood pressure cuff) may or may not be used. Some surgeons strongly advocate the bloodless field for nerve and tendon repair but the danger of a secondary ooze or hematoma must be considered. Personally I prefer to operate without the use of a tourniquet, and it is my opinion that its use predisposes to the death of much of the already traumatized tissue, whose blood supply has been impaired by the original trauma.

(7) Handle all structures, especially the nerve ends, with the greatest of gentleness. Do not crush the tendon ends with Allis clamps and do not use any sharp instrument in handling a nerve.

(8) Avoid, if possible, cutting across the normal flexion creases of the skin of the digits. Make a lateral rather than a midline incision.



(9) The use of fine black silk sutures is advocated for tendon repair as compared to the use of chromic gut, which often tends to tear the tendon when being passed through its substance, and which also causes more absorption reaction in tissues which frequently have no true circulation but are only bathed in lymph. A wide mattress suture about a centimeter away from the severed ends will approximate the tendon fragments and interrupted single sutures will improve the position of the opposing fiber ends (Figs 2, 3 and 4)

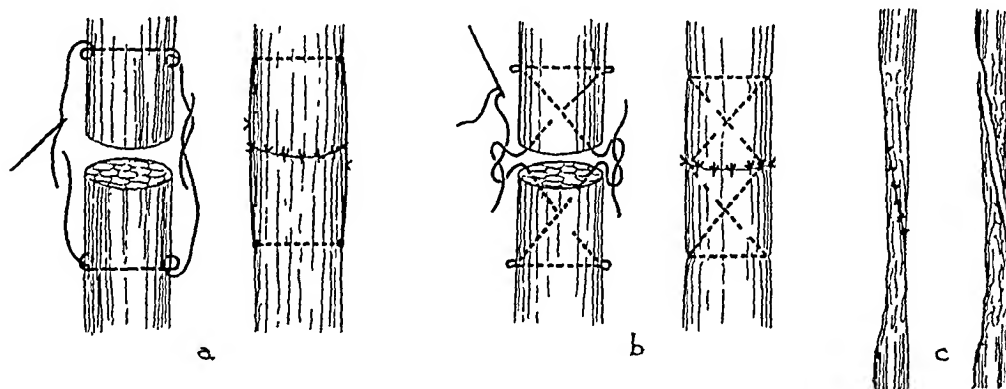


FIG 2—Method of approximating the ends of divided tendons (a) The preferred method (b) An alternative method (c) Method of approximating the fragmented ends of scarred tendons when end to end union of freshened tendon ends is impossible because of extensive destruction of tissue (S, G & O)

More fanciful stitches are usually unnecessary. Simple approximation is the best.

(10) The loss of substance of a tendon may be overcome by passing black silk sutures through a tunnel formed by a vein taken from another part or limb and then passing the suture through each severed end of the tendon.

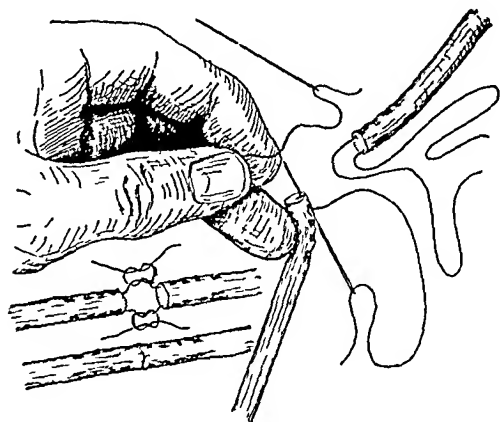


FIG 3—Bunnell's method of approximating the ends of divided tendons (J Bone and Joint Surg)

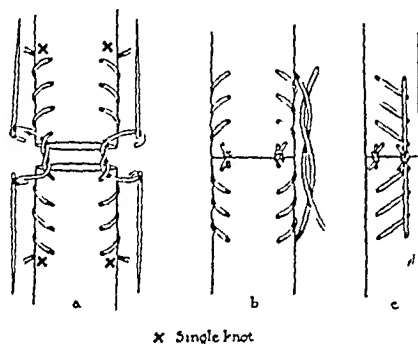


FIG 4—Hirner's method of approximating the ends of divided tendons (Boston M & S J)

Within a space of a few weeks fibroblasts will have formed a new pseudo-tendon.

(11) In lacerations of both digital flexor tendons between the metacarpophalangeal joint and the middle phalanx, which has been one of the most frequent injuries noted on our service, it is best not to attempt to repair both tendons. Repair only the long flexor—the profundus. If one repairs both at the same level, a large scar tissue growth will develop, causing adhesions.

between the tendons and the surrounding soft parts. One slip of the splitting insertion of the flexor sublimis tendon may then be used to form a new annular phalangeal ligament by passing it over the profundus tendon and sewing it to the lateral expansion of the digital extensor tendon. The formation of this new annular ligament will give a much better functional and cosmetic result.

(12) Do not drain these wounds. If drainage is necessary, surgery should not be attempted.

(13) Great effort should be made to cover the repaired tendon or nerve with subcutaneous tissue or fascia before suturing the skin. This usually prevents undesirable adhesions. The skin edges should be carefully sutured to insure primary healing.

(14) A molded plaster splint should be applied to immobilize the fingers and hand in either acute flexion or acute extension to relieve tension on the repaired parts. This splint should be modified and replaced from time to time during the postoperative course as the angle of immobilization is made less acute. The injured limb should be elevated or suspended overhead for four to six days following operation, as these wounds by their very nature are potentially infected. The elevation also will tend to prevent any venous oozing from small unligated venules, and will make the patient more comfortable by relieving him of that distressing and not infrequent postoperative complaint "throbbing."

*Postoperative Treatment*—The after care of these patients is just as important as is the operation, if they are to eventually obtain a good functional result. The surgeon should see the patient every day for the first three weeks, and after the initial ten to 14 days, depending on the type of injury, should commence some daily passive motion. I believe these patients would obtain the best functional results if they were hospitalized for three to four weeks postoperatively and not referred to the clinic. Although the expense would be great, the ultimate economic result to the patient would compensate for the added cost. An infection with a resultant "poor" functional result may cause a patient far greater discomfort, disability and loss of earning power than any fracture, hernia or any other form of traumatic injury.

*Functional Results Following Tenorrhaphy*—In the earlier years no considered follow up clinic was maintained, and as a consequence the final result of many cases could not be ascertained.

Of the 90 cases which were repaired a follow up was obtained on only 50 per cent of them. Sixty per cent of these had "satisfactory" results. Sixty-four of known end-results of lacerations of the fingers and 70 per cent known end-results of lacerations at the wrist terminated satisfactorily. The remaining 31 per cent had "unsatisfactory" functional results (Table IX).

Of the seven "poor" results five followed infections of the wounds and one was the result of a severe crushing of the carpus in a printing press which later necessitated a low amputation. The remaining "poor" result and

# SEVERED TENDONS AND NERVES

the unfavorable status of the seven "fair" results may be ascribed to such causes as too prolonged immobilization in splints, lack of cooperation on the part of the patient, too elaborate surgery resulting in adhesions of the re-

TABLE IX  
FUNCTIONAL RESULTS AFTER TENORRHAPHY  
*Follow Up of 45 of 90 Repaired Cases*

Total Cases Followed	45	
Excellent Result	15	} 31 Satisfactory (69%)
Good Result	16	
Fair Result	7	} 14 Unsatisfactory* (31%)
Poor Result	7	

\*12 of 14 unsatisfactory results were in flexor tendons Of these, 4 were at the wrist, 4 in palm and 4 in fingers

All poor results caused by either infections, crushing injuries or too long an immobilization in splints

paired tendons to one another or the neighboring skin, or the sutures failing to hold (Table X)

TABLE X  
ANALYSIS OF FORTY-FIVE KNOWN RESULTS

31 Satisfactory Results (69%)				14 Unsatisfactory Results (31%)			
15 Excellent		16 Good		7 Fair		7 Poor	
7 Ex-	13	3 Ex-		0 Ex-		2 Ex-	
tensors	Flexors	tensors		tensors		tensors	
8 Flexors	7 Wrists	7 Wrists	1 Hand	7 Flexors	1 Wrist	5 Flexors	1 Wrist
5 Wrists	2 Hands	6 Fingers	2 Fingers	3 Palms	(None)	1 Muscles	Crushing
3 Fingers	5 Fingers			(All Digi-		& Ten-	Injury
				tals to		dons of	Gangrene
				Digit III)		Forearm	and Am-
				3 Fingers		2 Wrists	putation
				(All Digi-		(Both	1 Hand
				tals to		Infected	(Large
				Digits		and De-	Infection
				II & III)		veloped	Slough)
						Claw	
						Hands)	

INCIDENCE OF NERVE INJURIES —Further analysis of the records for the past ten years shows that there were 26 severed nerves in 22 patients Eleven of these patients had associated tendon injuries which have been tabulated previously and 11 were admitted for nerve injuries alone Fifteen of the injured nerves were in the right arm and 11 in the left arm Every case of an injured nerve was in a male (one was a young boy) All but four nerves were repaired at operation The ulnar nerve was most frequently injured, being traumatized in 14 cases, while the median nerve was cut in ten people

Seven had secondary repairs and 15 had primary repairs Four patients had both their ulnar and median nerves severed Twelve of the 14 ulnar nerve lacerations occurred at the level of the wrist (Table XI)

*Complications*—Severed nerves may be complicated by formation of “neuromata” between their repaired ends if there is a poor approximation of the nerve tissues, or a rotation of part of the nerve trunk. “Trophic ulcers” are not infrequent complications, and more commonly found after ulnar

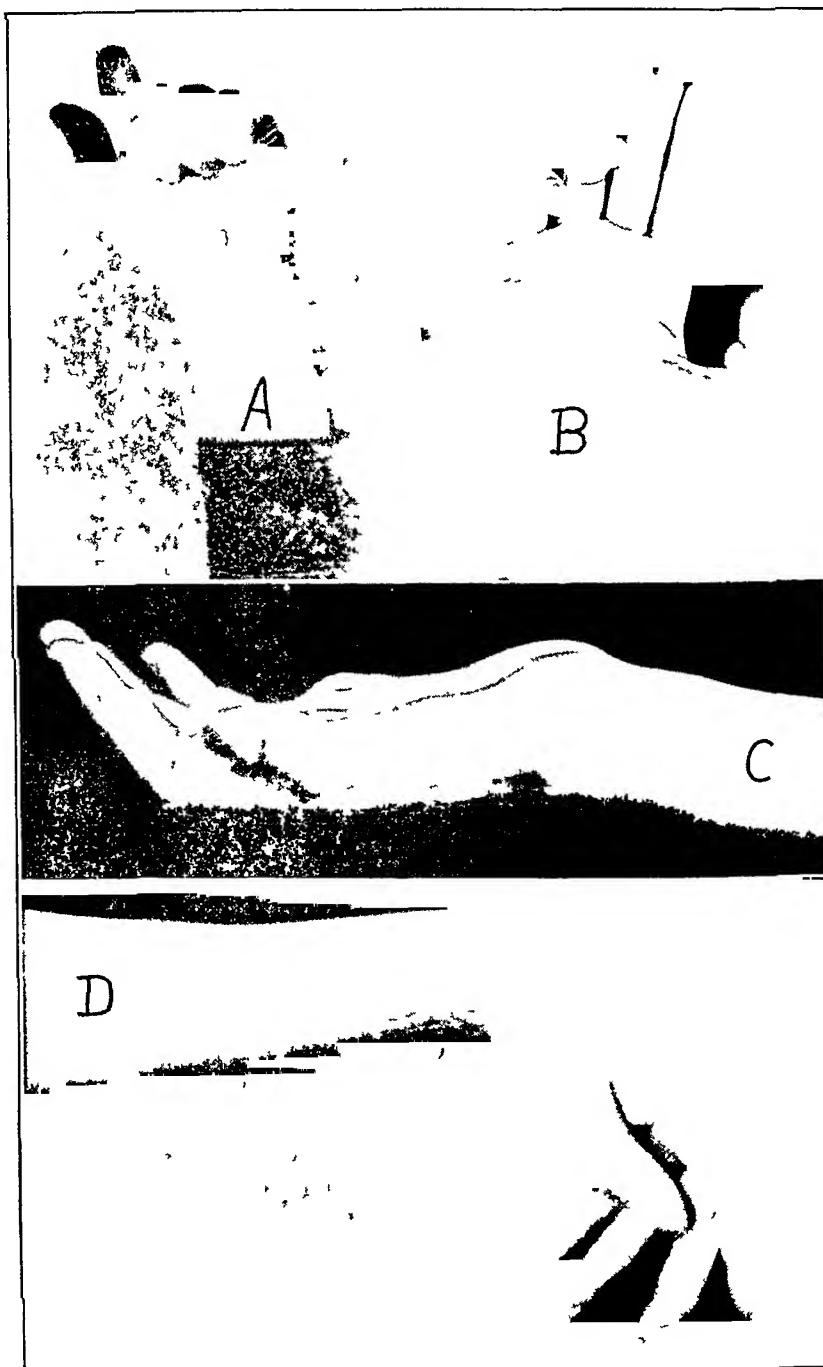


FIG 5—Deformities which indicate the nerve severed (A) Median (B) Ulnar (C) Median and ulnar (D) Radial (drop wrist) (from Morris Anatomy, P. Blakiston's Son & Co, Inc, publishers)

nerve injury than following severance of the median nerve (Fig 7). The predisposition for such an ulcer can be accentuated by the excessive pressure of a splint.

# SEVERED TENDONS AND NERVES

TABLE XI

ANALYSIS OF TWENTY-SIX NERVE INJURIES IN TWENTY-TWO PATIENTS

26 Nerves in 22 Cases  
11 Cases Had Tendon Injuries  
11 Cases Uncomplicated  
24 of 26 Injuries Were of the Wrist (2 Forearm)  
3 Nerves Not Repaired (Partially Severed)

Right (11)

Left (15)

5 Median Nerves

4 Ulnar "

1 Radial (Branch)

1 Musculo-Cutaneous

5 Median Nerves

10 Ulnar "

All Cases Were in Males

4 Cases Had 2 Nerves Severed

12 of 14 Ulnar Nerve Lacerations Were at Wrist

All 10 Median " " " " "

Cases { 12 in Left Limb  
10 in Right "

Nerves { 15 in Left Limb  
10 in Right "

Complications { Neuromata  
Trophic Ulcers  
Adhesions to Scars of Tendons

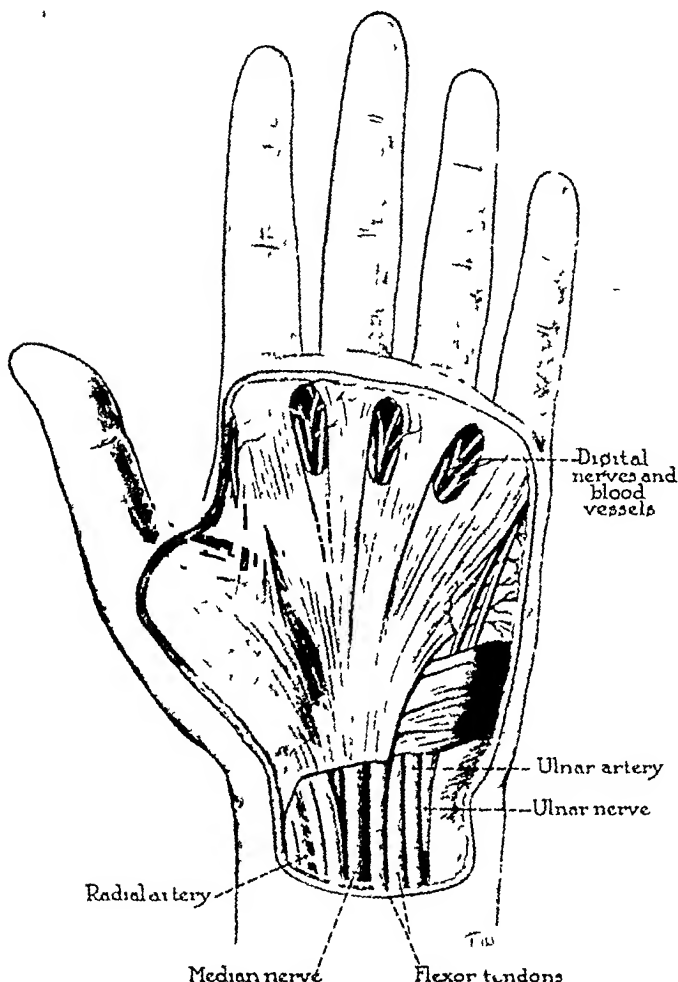


FIG 6—Dissection of the volar surface of the wrist showing the superficial position of the median and ulnar nerves, and the similarity in size between the median nerve and the superficial flexor tendons (after Sobotta) (S, G & O)

Adhesions of the tendon scars to the damaged nerve may cause the patient considerable distress. The regeneration of sensory power after ulnar nerve lacerations and repair is more rapid than is the motor function, which

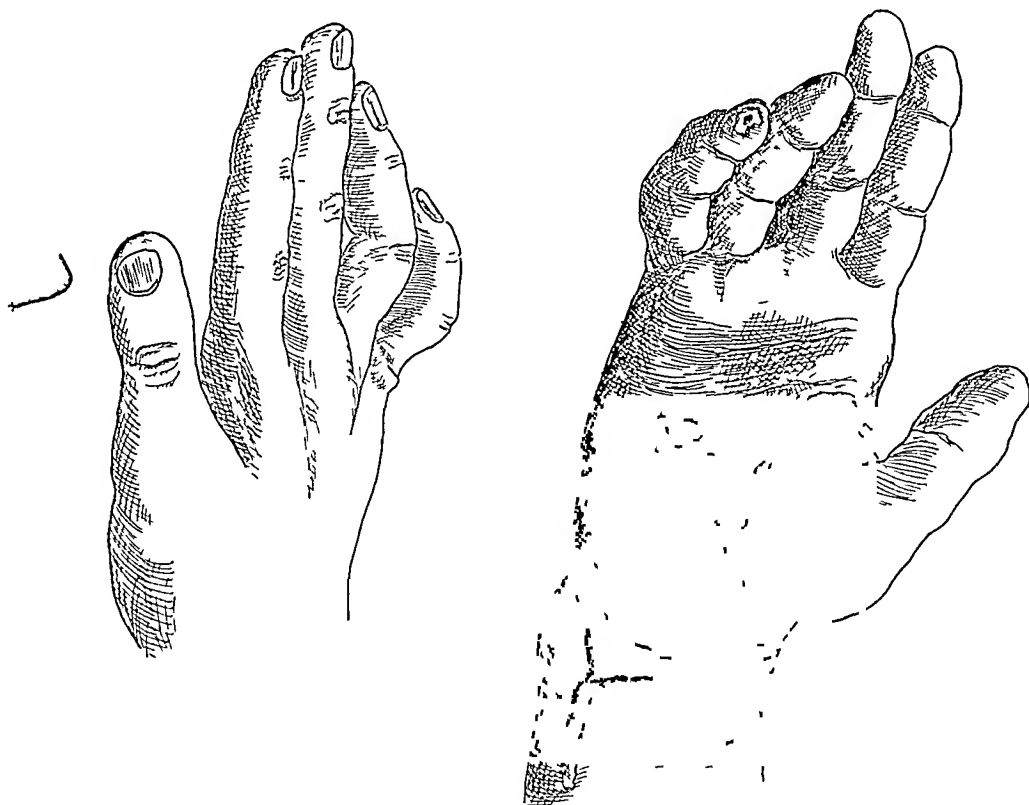


FIG 7—Trophic ulcer following severance of ulnar nerve

frequently may not occur until one year later. Infections are not as dreaded a complication here as they are in tendon injuries and none of the 11 cases which were operated upon for nerve injury alone became infected.

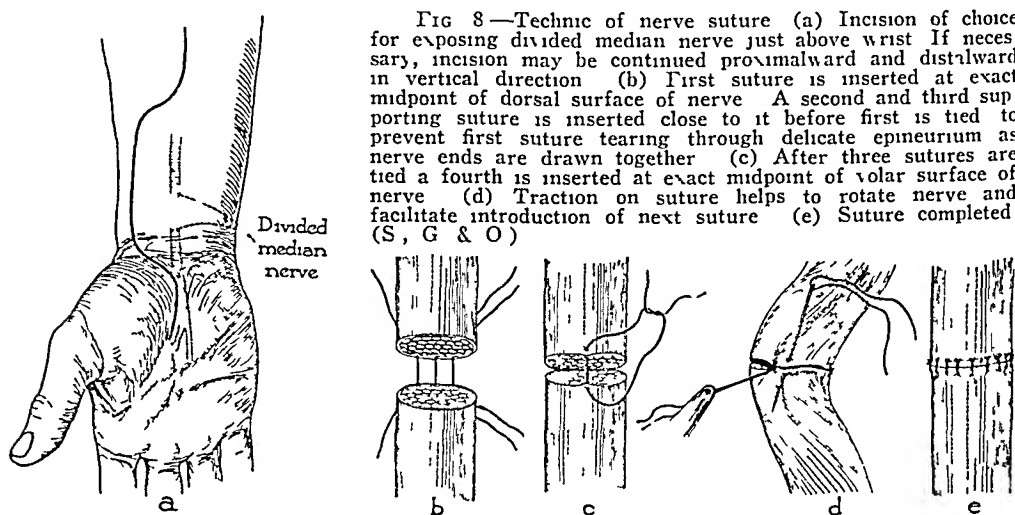


FIG 8—Technic of nerve suture (a) Incision of choice for exposing divided median nerve just above wrist. If necessary, incision may be continued proximalward and distalward in vertical direction. (b) First suture is inserted at exact midpoint of dorsal surface of nerve. A second and third supporting suture is inserted close to it before first is tied to prevent first suture tearing through delicate epineurium as nerve ends are drawn together. (c) After three sutures are tied a fourth is inserted at exact midpoint of volar surface of nerve. (d) Traction on suture helps to rotate nerve and facilitate introduction of next suture. (e) Suture completed (S, G & O)

*Technic of Nerve Suture*—All severed nerves should be sutured with about six to eight interrupted black silk sutures passed through the neurolemma sheath (FIG 8). In addition, the passing of a suture through the

trunk of the nerve about one centimeter from its severed ends, before freeing it from its surrounding soft tissue bed, apparently does not injure any nerve fibers, as it passes through the substance of the nerve and it has the advantage of preventing a rotation of the nerve ends after they have been freed from the surrounding structures and gives better apposition of the injured parts. The constant irrigation of the wound with saline while suturing the nerve diminishes the probability of the formation in its trunk of scar tissue due to the absence of any blood between the opposing severed ends. Some surgeons advocate the encasing of the repaired nerve in a pad of fat (Fig 9) from the abdominal wall or the surrounding soft parts so as to prevent adhesions, but this is usually unnecessary.

A partially severed nerve should be repaired to prevent scar tissue formation hindering the regeneration of the nerve fibers in their axis cylinders. Handle all nerves with the greatest of care and gentleness. If the nerve was severed in such a manner as to leave jagged ends, cut them cleanly across with a sharp scalpel and approximate the ends perfectly. Here, as in repaired tendons, a molded plaster splint must be applied to hold the wrist in a position where all tension is removed from the repaired nerve for three weeks' time (which is a longer time than for tendon immobilization).

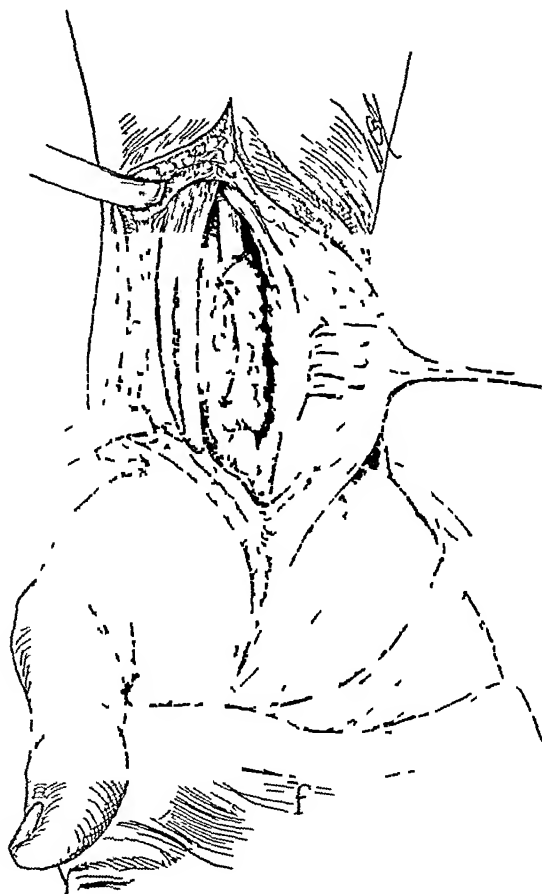


FIG 9—Shows protection of line of suture with thin fat transplant (S, G & O)

TABLE XII

FUNCTIONAL RESULTS AFTER NERVE REPAIRS

*Follow Up of 13 of 22 Repaired Nerves*

5 Excellent Results	{ 3 Ulnar 2 Median
3 Good Results	{ 2 Ulnar 1 Median
5 Poor Results	{ 3 Ulnar 2 Median

*Functional Results Following Nerve Suture*—Of the 22 repaired nerves of the forearm, the end-results of 60 per cent are recorded, showing 61 per

cent are satisfactory. There was no difference in the regeneration of the different nerves as 62 per cent of the ulnar and 60 per cent of the median nerves had their function restored.

#### CONCLUSIONS

**TENDONS**—(1) Primary repairs of tendons should be performed whenever possible. The time between the injury and the operation should be as short as possible and the suture material of choice is fine black silk.

(2) The simple mattress stitch will approximate the tendon ends and destroy fewer lymph channels. More elaborate methods of suture are unnecessary and may be harmful as they tend to diminish the circulation in the tendon and prolong the operation.

(3) Do not repair both digital flexor tendons in the hand. Repair only the long flexor—the profundus.

(4) Repaired wounds should never be drained. If drainage is necessary, do not perform a primary repair.

(5) Infection occurred in 13.33 per cent of the lacerated wounds, and usually resulted in a poor functional result.

(6) The end-result is greatly dependent upon the surgeon's personal management during the first three or four weeks of postoperative care.

(7) A follow up of 50 per cent of the repaired tendon cases is recorded, showing satisfactory functional results in 69 per cent of the cases. Five of the seven known "poor" tendon results followed severe infections.

**NERVES**—(1) A partially severed nerve should be repaired in order to prevent the formation of scar tissue, which hinders regeneration of the nerve fibers.

(2) A follow up of 60 per cent of the repaired severed nerves showed satisfactory functional results in 61.5 per cent of the cases.

(3) It is essential to stress the necessity of perfection of the surgical technic and asepsis as well as gentleness in the handling of the tissues in these cases.



# PAINFUL SHOULDER

ARISING FROM

LESIONS OF THE SUBACROMIAL BURSA AND SUPRASPINATUS TENDON

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It is not the purpose of this paper to discuss all the possible painful lesions of the shoulder region but rather to detail experiences in the treatment of the soft tissue lesions involving the subacromial or subdeltoid bursa and the supraspinatus tendon in 200 patients

The lesions to be discussed are (1) Acute traumatic bursitis, (2) acute bursitis with calcification, (3) subacute bursitis with calcification, (4) chronic bursitis, and (5) tendinitis or obliterative bursitis

It is proposed to outline the significant points in the history and examination of each lesion, to describe as far as possible the pathologic change giving rise to the symptoms, to relate therapeutic measures which have been used, and finally to report the prognosis as observed in a series of cases (Table I)

ACUTE TRAUMATIC SUBDELTOID BURSITIS.—The patients included in this group are those who have pain in the shoulder region following either direct or indirect trauma to the shoulder. The direct trauma may be a blow or fall upon the shoulder, and this is always associated with contusion of the deltoid. Indirect trauma usually results from a fall upon the arm or elbow with the arm in partial abduction. The arm is driven up toward the shoulder by a force transmitted along the long axis of the humerus, or the arm may be forcibly pushed underneath the body by the fall while an effort is being made to produce an abduction movement. Naturally, in many such injuries, the exact mechanism of the trauma cannot be accurately learned, but generally a clear history stating that the shoulder itself did not receive direct trauma may be obtained

Soon after the injury there is a rather acute tenderness over the greater tuberosity, which becomes less with the passage of time. The patient complains of pain on abduction of the arm. There is often only a portion of the abduction arc in which severe pain is experienced. Usually there is persisting soreness which may be present in decreasing intensity for several days after the injury. On examination, the patient's description of a painful point during abduction movement is confirmed and it may be demonstrated that abduction against resistance is markedly painful even in the lower portion of the abduction arc. Examination should be made for evidence of injury to the acromioclavicular joint as shown by tenderness on pressure over it. In cases with more severe trauma, abduction movements may be very markedly limited due to pain, and in such cases there may be considerable difficulty in making a differential diagnosis between simple acute traumatic bursitis and

partial tear of the supraspinatus tendon As a matter of fact, however, this differential diagnosis is not important in most cases because treatment of traumatic bursitis and minor tears of the supraspinatus is practically the same

TABLE I  
RÉSUMÉ OF LESIONS CAUSING SHOULDER PAIN

	Acute Traumatic Bursitis	Acute Bursitis with Calcification	Subacute Bursitis with Calcification	Chronic Bursitis	Tendinitis or Obliterative Bursitis
Symptoms	Direct trauma to shoulder Indirect trauma through arm Soreness in shoulder	Intense constant pain in shoulder	Pain in shoulder worse on abduction Nocturnal Often history of trauma	History of trauma Pain in certain degrees of abduction	History of slight trauma or overuse Slowly increasing pain Increasing disability in abduction and external rotation
Findings	Tenderness over greater tuberosity Pain on motion especially abduction	Acute tenderness over greater tuberosity No shoulder motion because of pain	Tenderness over greater tuberosity Pain on abduction but motion possible	Tenderness over greater tuberosity Slight limitation of motion Pain and click on abduction	Slight deep tenderness greater tuberosity Atrophy of shoulder muscles and spasm Restriction of motion
Cause of symptoms	Traumatic inflammation of bursa due to (1) contusion between greater tuberosity and acromion and (2) slight tears of supraspinatus tendon	Inflammatory tension in area of calcification	Traumatization of area of calcification in supraspinatus tendon Reflex spasm of supraspinatus	Thickening of bursa villi formation and bands	Adhesive bursitis Loss of gliding function in bursa
X-ray findings	Negative	Large area of calcification over lateral edge of greater tuberosity	Small area of calcification on top of greater tuberosity	Changes in greater tuberosity Excrescences	Negative
Treatment	Immobilization Heat Gradually increasing exercises within pain limits	Incision and evacuation of calcified area under local anesthesia	Rest heat, sedative Local anesthetic injection into bursa Exercises within pain limits	Rest heat Excision of villi bands and excrescences	Injection with novocain Manipulation Heat diathermy Exercises
Prognosis	Good Recovery in 2 to 3 wks	Good Immediate relief of pain Normal function	Eventually good Acute symptoms subside in 1 to 3 wks Eventual recovery	Good Recovery in 3 to 4 wks	Eventual recovery Progress slow

In major or complete tears of the supraspinatus tendon the symptoms are usually so definite that there can be no confusion

The cause of these symptoms is an acute traumatic inflammation of the subdeltoid bursa In cases caused by direct trauma, there is an associated

contusion of the deltoid. In those produced by indirect trauma, the inflammation is produced either by the greater tuberosity and the supraspinatus tendon being driven against the acromion or by partial tears at the insertion of the supraspinatus tendon on the greater tuberosity. The latter injury can hardly take place without some injury to the floor of the bursa which lies immediately over the tendon.

A roentgenologic examination should always be made in order to rule out the possibility of fracture.

The treatment of acute traumatic bursitis is immobilization of the shoulder with later applications of heat. A very effective method of immobilization is by means of adhesive strapping (Fig 1). Moist heat or dry heat by means of an electric pad or diathermy is valuable after two or three days. Immobilization should be continued for a period of at least a week or ten days, then exercises, gradually increasing in range, will permit the patient to recover normal function of the shoulder within a period of three to four weeks after the injury. The difficulty in these cases is in maintaining immobilization and restricted motion long enough to permit the traumatic inflammation in the region of the bursa to subside. The prognosis in these cases is good but it should be remembered that the acute trauma, especially if repeated, may lead to one of the more disabling lesions.

**ACUTE SUBDELTOID BURSITIS WITH CALCIFICATION**—There is no mistaking the patient suffering from acute bursitis with calcification. He comes nursing the affected arm as tenderly as he would if he had a fractured clavicle (Fig 2). He refuses to move the arm at the shoulder, and his haggard face confirms his story of sleepless nights because of a constant, intense pain in the shoulder often radiating down the arm. Acute tenderness is found on slight pressure over the greater tuberosity. Further examination can hardly be made because of pain experienced by the patient.

The cause of the acute symptoms in these cases is tension in a calcified area in the supraspinatus tendon in the floor of the subdeltoid bursa. This



FIG 1—Adhesive tape strapping of shoulder. Longitudinal strips are fixed first to the arm, beginning about midway between the shoulder and elbow. They are then pulled firmly upward over the shoulder, those from the anterior surface of the arm across the point of the shoulder to lie over the scapula, and in the same manner, those from the posterior surface of the arm cross over the shoulder to become attached to the anterior upper chest. Transverse strips around the arm and across the shoulder fix the ends.

area, which has probably been present for some time, seems suddenly to become the seat of an inflammatory process, and being confined in a dense tissue, the tension produced causes an intense pain. Any attempt to move the arm increases the tension in the calcified area with a consequent increase in the pain.

A roentgenologic examination is of value in confirming the diagnosis. In these acute cases there are two things that stand out in the roentgenogram: the calcified mass appears to be large, and it usually lies well down over the greater tuberosity (Figs 3A and B).

The therapeutic indication is relief of the tension by incision of the area



FIG 2—Typical position of patient with acute bursitis with calcification of right shoulder

of calcification, which operation can be performed under local anesthesia, as described by Codman. The use of adrenalin in the novocain makes the operation practically bloodless. A small incision is made over the greater tuberosity, separating the fibers of the deltoid and the roof of the bursa. In typical cases, the lesion is found presenting over the greater tuberosity exactly as Codman describes it. There is a circular red zone of small injected vessels surrounding a pale area of calcification. This area has been found in most cases to lie to the lateral edge of the greater tuberosity. If the incision has been properly placed, the calcified area presents in the wound. If it is not immediately visualized, rotation of the greater tuberosity will bring it into view. Having localized the area of calcification, a small nick in its surface

readily demonstrates the tension which is causing the pain. White, soft material of a consistency and appearance of tooth paste pours out of the incision and curls up in the wound. With this relief of tension the patient experi-



FIG 3—(A) Roentgenogram of patient in Fig 2. (B) Roentgenogram of another similar case. Note typical position and relatively large area of calcium deposit in the acute bursitis with calcification.

ences immediate relief of the intense pain which has tormented him. Usually the incision is enlarged and as much as possible of the calcified material



FIG 4—Same patient as Fig 2, two weeks after incision and evacuation of calcified area.

is removed gently with a curette. No effort is made to excise any of the wall of the calcified area to which clings much of the pasty material. The wound in the bursa and deltoid is closed with a layer of catgut sutures and

the skin is closed with mattress sutures of silk. A simple pressure dressing is applied and a sling is adjusted.

This treatment gives such immediate relief from the excruciating pain that the discomfort caused by the wound is minimal in comparison. Five patients so treated have been ambulatory cases (Fig 4). The prognosis is good in all cases. Immediate relief is followed by recovery without disability in one to two weeks.

**SUBACUTE BURSITIS WITH CALCIFICATION**—The patients in this group complain of disabling pain in the shoulder, but it is not so constant or intense as in the former group. The pain does not prevent movement of the arm at the shoulder, but it is caused by abduction so that the movement of putting on a coat causes a sharp pain in the region of the shoulder. As a rule the pain appears if the patient lies on the affected shoulder and is for this reason often noted at night. There is not infrequently obtained a history of previous occasional pains in the shoulder and often of an injury or unusual use of the arm and shoulder.

Examination demonstrates pain on abduction of the arm. Usually it is most acute as the greater tuberosity passes under the acromion. There is tenderness on pressure over the greater tuberosity, but this is not nearly so marked as that noted in the acute type.

Roentgenologic examination shows an area or areas of calcification but these are not usually so dense or so large as noted in the acute variety and they are found located on top of the greater tuberosity rather than along its lateral edge (Figs 5A and B).

The pathology consists of an area of calcification in the supraspinatus tendon beneath the floor of the bursa. There is no tension in the calcified area and no pain until the area is traumatized either by prolonged or unusual use of the supraspinatus, or by pressure of the area against the acromion in abduction. The supraspinatus is often found to be in a reflex spasm, probably caused by the pain in the region of the calcified area.

The treatment of these cases should be conservative. The indications are rest of the affected arm and shoulder and applications of heat during the painful stage. In about one-half of the cases baking and diathermy are effective in relieving the pain and in causing a rapid subsidence of the symptoms. Sedatives are necessary in the early phases of the treatment. In those cases in which heat and rest are not immediately effective, and especially in those with marked spasm of the supraspinatus, injections of 20 to 30 cc of 1 per cent novocain into the region of the bursa are often effective. The injection apparently blocks the pain sensations and sets at rest the hyper-irritable supraspinatus. After the more acute symptoms have subsided with either heat or injection, active exercises within pain limits are of most value. The prognosis for eventual recovery is good.

Operation in subacute bursitis with calcification is mentioned only to be condemned. An experience with a few such cases serves to forcefully teach this lesson. The operation itself is often embarrassing, for after opening the

## PAINFUL SHOULDER

bursa, there is no telltale circular zone of hyperemia to mark the area of calcification. A considerable search is often necessary, in spite of roentgenologic localization, before the dense chalk-like calcified area is found. It is deep in the substance of the supraspinatus tendon and does not present in the floor of the bursa. It seems that perhaps more harm than good is accomplished by making an opening through the tendon at the greater tuberosity in order to remove a relatively innocent appearing area of calcification. The results appear to bear this out, for usually the patient is not relieved of his symp-

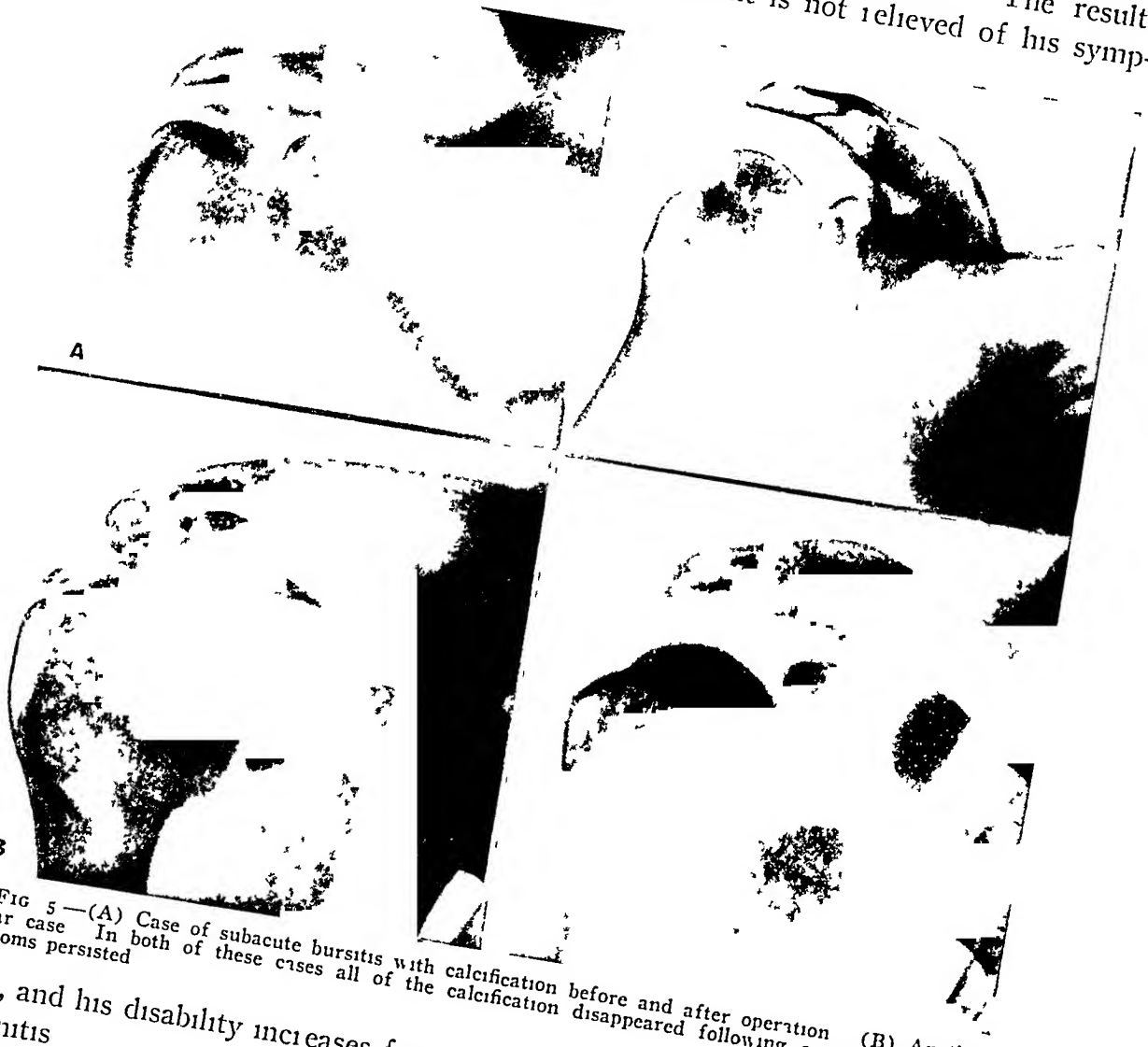


FIG 5—(A) Case of subacute bursitis with calcification before and after operation. (B) Another similar case. In both of these cases all of the calcification disappeared following operation, but the symptoms persisted.

toms, and his disability increases for a time and sometimes even goes on to a tendinitis.

**CHRONIC BURSITIS**—The patients included under this heading are those who complain of pain in the shoulder in a certain range of abduction of the arm. They are usually in the fourth and fifth decades of life, and practically always a history is obtained of either direct or indirect trauma to the shoulder. The trauma is followed by a short-lived, but definite pain in the shoulder, and often there are several such incidents. Eventually, due either to overuse of the arm usually in abduction or to another injury, the pain reappears.

On examination, there is found little or no limitation of motion of the arm at the shoulder and there is no atrophy or marked spasm. However, when the arm is abducted to a point about where the greater tuberosity passes under the acromion, the patient notices a sharp pain in the shoulder, and he gives a downward jerk of the shoulder. This seems to be a help in passing the painful point because the arm may then be fully abducted without further discomfort. The same painful point seems to be present as the arm is brought to the side again from an overhead position. In addition to the above finding, a click or crepitation may be palpated over the tip of the shoulder in abduction movements. The click is usually felt at the time in the abduction motion when the patient experiences pain. The painful point noted in abduction and the click are not nearly so definite when the arm is raised in the extended position and in some patients this motion may be made without any pain at all.

The cause of these symptoms appears to be a chronic traumatic inflammation of the floor of the subdeltoid bursa, the traumata having resulted in repeated small defects at the insertion of the supraspinatus tendon on the greater tuberosity. These are described by Codman as straps and he believes they are separations of a lamina-like group of strands of tendinous tissue from the parent tendon, which push up in the floor of the bursa in abduction. Trauma may also cause the development of villi which extend across the bursa and are similar to those which are seen in other bursae following repeated injury. Some of these villi appear to be thicker and more fibrous and extend across the bursa in a cord-like string. These have been given the name of bands by Codman. In addition to these changes in the floor of the bursa over the point of the insertion of the supraspinatus tendon, there are often changes in the greater tuberosity itself, as a result of these injuries to the supraspinatus tendon. These changes are easily demonstrable roentgenologically as excrescences at the tip of the greater tuberosity, eburnation of bone and areas of reduced density in the greater tuberosity and adjacent shaft of the bone (Fig. 6).

The treatment of this type of chronic bursitis may be divided into the conservative and the operative treatment. Since the symptoms almost invariably arise from trauma it might be expected that rest of the shoulder and applications of heat might give good results in many cases. This reasoning has proved correct in the majority of our cases. However, in a few patients, where symptoms persist in spite of conservative therapy, incision of the bursa and excision of the offending villi, bands, straps, or excrescences seemed logical. This therapy has been successful in the four cases in which it has been used.

The prognosis in chronic bursitis is good. As a rule, under conservative therapy, relief of symptoms may be obtained in three to four weeks. When symptoms persist beyond this time, operative intervention is indicated, with the prospect of relieving the symptoms in another three to four weeks. In one patient there was complete relief of all symptoms 15 days after the re-



removal of hypertrophic villi and several small excrescences from the great tuberosity

**TENDINITIS OR OBLITERATIVE BURSITIS**—The cases included in this group are those which have commonly been described under the headings of bursitis, peri arthritis or neuritis of the shoulder and arm. These patients are practically all 40 or more years and there is generally a history of direct or indirect trauma to the shoulder or of overuse of the arm. The pain in such cases appears to develop slowly and to increase gradually over a period of weeks. Characteristically, the pain appears somewhat lower down over



FIG. 6—Rarefaction at the greater tuberosity

the deltoid than in the other lesions previously described, although this is not invariable, and there is usually a radiation of the pain down the arm to the elbow and extending even as far as the hand. In addition, there is at times a radiation of the pain upward over the neck and scapula. The pain appears to be worse at night and the patient usually complains that he is unable to sleep on the affected side. Any attempt to move the arm away from the body, either in abduction or in extension causes pain.

On examination, there is usually noted marked atrophy of the deltoid and other shoulder muscles. Tenderness on pressure over the greater tuberosity and well down along the humerus toward the deltoid tubercle is usual. Attempts to abduct the arm are restricted by an apparent fixation of the struc-

tures in the region of the shoulder, thus has arisen the term "frozen shoulder" as applied to this condition. Efforts to passively abduct the arm demonstrate the marked involuntary spasm of the shoulder muscles which is so characteristic of these cases. Not only is it impossible to abduct and extend the arm at the shoulder but in many instances rotation, especially external rotation, is impossible.

The pathologic process which appears to cause the symptoms is a chronic adhesive bursitis in which there is a functional loss of the gliding mechanism in the subdeltoid bursa. The adhesions are, as a rule, traumatic in origin and are probably the result of frequent minor traumata to the bursa and of tears in the supraspinatus tendon producing subacute symptoms.

Roentgenologic examination usually shows few or no changes in the greater tuberosity although in a few cases there may be a roughening at the edge and, in some, excrescences appear along the tip of the acromion.

These patients are among the most difficult of all to treat. Their arms are practically useless, especially if their occupation demands abduction. The treatment should consist in stretching or rupture of the adhesions so that the gliding function of the subdeltoid bursa may be resumed. Conservative treatment consists in applications of heat, usually in the form of diathermy, with exercises within pain limits. Under this therapy progress is slow and often discouraging to the patient although recovery will almost invariably take place after a period of months. A second method of treatment which has proved more successful, in a majority of our patients, has been the injection of 20 to 30 cc of a 1 per cent novocain solution into the region of the subdeltoid bursa. The injection has a twofold purpose, one of stretching and dilating the tissues in the region of the bursa and thus providing for some gliding movement and, second, the injection being anesthetic, it produces a more or less complete relief of painful stimuli from this area and so permits manipulations of gradually increasing range. The manipulations should be carried out at first carefully and slowly to the limit permitted by the adhesions. As a rule, internal and external rotation movements are first tried, followed by circumduction movements at the shoulder with a gradually increasing range. During the manipulations there may often be a palpable and even an audible snap, after which practically full range of motion may be obtained. In some cases, when the pain is too marked to permit adequate manipulation, it has been found advisable to give a second injection of novocain.

For the first 24 hours after the injection and manipulation there may be an increase in the pain and soreness in the shoulder. This may persist for a day or two in decreasing intensity. Thereafter the discomfort usually subsides except on movement of the arm.

The best results, of course, are obtained when there has been a sensation of a snap or rupture of an adhesion during manipulation. These patients obtain almost complete range of motion of the shoulder without discomfort after a week or two. In the patients treated without injection, exercise is an important therapeutic measure. Codman's stooping exercises, in which the

## PAINFUL SHOULDER

patient leans forward and swings the arms forward and backward trying each time to bring the arm as far as possible towards the head, have been found to be a very useful procedure. In some patients the swinging of some heavy object, such as a dumbbell or an old fashioned flat-iron, has provided an increased inertia sufficient to stretch the adhesions and provide an increased range of motion. Another exercise which has proved valuable is so called wall climbing in which the patient creeps up the wall with his fingers (Fig 7). It is useful in some cases to have the patient mark the upper limit which he can reach so that he may note his daily progress by the



FIG 7—Wall climbing exercise. The patient creeps up a vertical wall with his fingers.

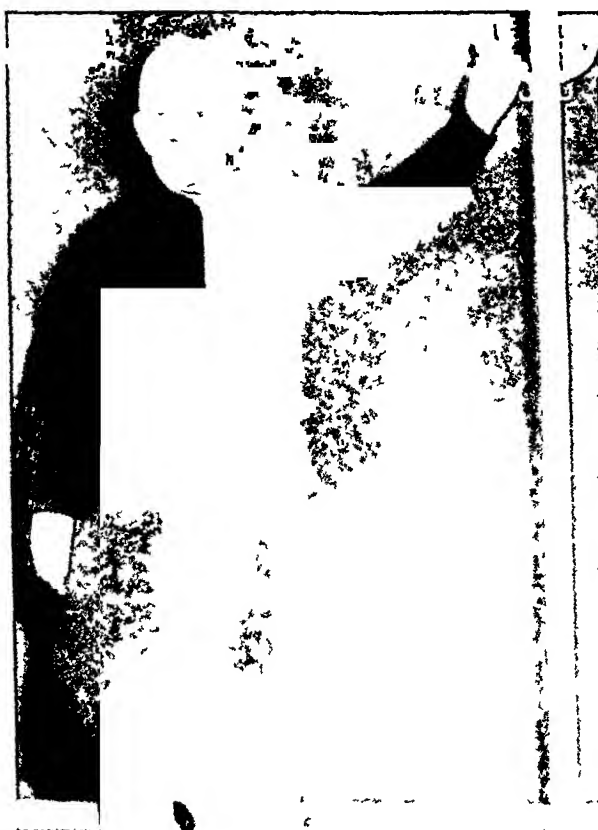


FIG 8—Abduction exercise to stretch adhesions in the shoulder bursa. The patient grasps an object at his side. Abduction motion is increased by bending the knees.

increasing height to which his fingers will obtain. Abduction exercises are provided by having the patient grasp some object at his side. Then by bending his knees abduction is obtained at the shoulder. Patients are often less timid about producing abduction by knee bending with the arm fixed than by moving the arm with the body fixed (Fig 8). Another exercise which will utilize the same principle is one in which the patient grasps a banister, table or some other object about waist high. He then backs away from the object with his hands still in place, by bending the knees further stretching of the adhesions is produced (Fig 9).

All of these exercises may be carried on in the home and the faithfulness and effort of the patient is a big factor in his progress. Some patients may improve in a period of three to four weeks, sufficient to obtain almost normal

function in the shoulder joint. In others the progress may be slow, but the prognosis for eventual recovery and normal shoulder function is good in practically all cases, although a degree of recovery approaching the normal may not take place for as many as 6 to 12 months.

COMMENT—The above outline of the diagnosis and treatment of painful shoulder due to lesions of the shoulder bursa and the supraspinatus tendon presents the subject in much more simple fashion than is often encountered clinically in the patient. In spite of definite criteria upon which the diagnosis is made, a differential diagnosis is often difficult for the reason that many of



FIG 9—Adhesions in the shoulder bursa being stretched by grasping some waist high object and backing away from it. When the patient has reached the pain limit, additional stretching is obtained by bending the knees.

these lesions may be combined or may follow one another, the one leading to the other so that the history is by no means clear and the findings may fit into several diagnoses. In other instances the diagnosis may be confused by other injuries in the shoulder region such as dislocation of the shoulder, fracture of the greater tuberosity or of the upper humerus. In spite of these facts, however, an adequate history and a careful physical examination will as a rule give the examiner a fairly clear mental picture of the pathologic process with which he is dealing. This is important because the success of the treatment depends in large part upon an exact knowledge of the lesion being dealt with.

A statement should be added regarding the effect of toxic absorption and focal infection upon the production and course of these lesions. Since the

possibility of such an effect has been mentioned in many discussions of the etiology of chronic bursitis and tendinitis and even of those cases with calcification in the supraspinatus tendon, in many of the cases observed an investigation of possible foci of infection has been made, including the colon as a source from which toxic absorption may occur. In those cases in which foci of infection were found and eradicated no special benefit seemed to follow, and it has never been possible to definitely trace etiologic relationship between the painful lesions described and toxic absorption from foci of infection or from the colon. The constancy with which a story of trauma appears in the history of patients with painful lesions of the shoulder points to the relative importance of injury as the outstanding etiologic factor in these cases.

DISCUSSION—DR DONALD GORDON (New York) In regard to acute traumatic subdeltoid bursitis, I would add nothing except that in my experience I have found that a simple axillary pad, sling and swathe, make a more comfortable and efficient immobilization of the shoulder than adhesive plaster. This can be done with two bandages and a bundle of cotton and a few safety pins. It is easily removed for examination and therapy, which the adhesive does not permit. Doctor Ferguson does not mention an axillary pad, but where there is much space between the arm and the body at the elbow, close approximation of the arm to the body without a pad causes pressure on the bursa through the tense deltoid pressing on the swollen bursa by this arm adduction. I feel he does not sufficiently stress the danger of this type progressing to the "frozen shoulder," so called, by reason of inadequate treatment, though he feels as I do, that this is a common precursor of the shoulder with muscular contracture. In cases of this kind where severe pain has existed for a few days with much muscle spasm, I use immobilization and ambulatory traction, which I would like to suggest as an efficient therapeutic measure, when operation is not indicated or consented to.

The late Doctor Brickner of New York was one of the first to operate upon cases of calcified bursitis, the pathology of which Dr Eli Moscovitz has described so well, but who had observed that these calcified areas frequently disappeared without operation. The largest conically shaped mass I have ever seen disappeared in ten days without operation. We are all familiar with the fact that these opacities are present in shoulders which are not painful, as well as in those which are painful, in the same patient. I have found it difficult to understand, if these areas of calcinosis are due to trauma alone, how further trauma by operation could cure them unless it was by aiding vascularization in an area of marked ischemia.

Curiously similar lesions are rarely seen, if at all, following fractures about the greater tuberosity, where the fracture lines have opened up a new vascularity, although there is an increase in the possibility for trauma due to the slightly elevated fragment. Also we do not get the bursal syndrome if muscular contracture has been avoided. The short period of recovery, however, in Doctor Ferguson's cases is the best criterion of the efficacy of the procedure in his hands whatever may be the academic view of the pathology.

I am unable to understand how, with the similarity of pathology and symptoms between subacute bursitis with calcification and the acute variety, operation is not of service if it releases tension only, unless the calcinosis being in the supraspinatus tendon, it is in a more avascular area than when it lies in the floor of the bursa.

I have never tried the injection of novocain, because I felt that it was a temporary sedative which would not correct the pathology. However, if such blocking of the protective mechanism will permit sufficient muscular activity without pain, to prevent atrophy of disuse and loss of coordination, its use should be of real value, and I feel that this is the basis for part of its success in Doctor Ferguson's hands. I feel also that the needling associated with such anesthesia must of necessity be of value in vascularization. Furthermore, if anesthesia permits increased function, and trauma has been an exciting factor, I am again at a loss as to why it cures, unless this type of lesion has the pain of contracture, which limited exercises correct if they can be done without pain.

Doctor Ferguson described the causative pathology of the symptom complex of tendinitis as due to "a chronic adhesive bursitis in which there is a functional loss of the gliding mechanism in the subdeltoid bursa." If it is a chronic adhesive bursitis, why call it tendinitis? The latter term seems to me to apply more aptly to his classification with calcinosis in the supraspinatus tendon insertion. Also there are many structures which move on each other in scapulohumeral movement. In fractures of the greater tuberosity, where there must be bursal adhesion and tendon injury, I have not seen this symptom complex.

The limitation of shoulder movement in these cases I believe is due to muscle contracture following prolonged muscle spasm caused by splinting the painful shoulder rather than spasm alone, which must be carefully differentiated for the purpose of treatment. The pain referred to the deltoid insertion, extending up the cervical plexus and down the arm to the hand, is present only when muscle contracture exists. Improvement in pain is directly proportionate to the improvement in muscle contracture. If novocain will permit the gentle stretching which is imperative in connection with other therapy, I think it is an excellent point.

Doctor Ferguson states that in his experience with cases studied "it has never been definitely possible to trace etiologic relationship between the painful lesions described and toxic absorption from foci of infection, or the colon." This is contrary to my experience. To cure patients of these lesions, I cannot overlook foci of infection as an etiologic factor however indirect the relationship. I am almost convinced from experience, that his last group is one of arthritis or peri-arthritis.

# GAS GANGRENE

A REVIEW OF THIRTY-TWO CASES WITH SPECIAL REFERENCE TO THE USE OF  
SERUM, BOTH PROPHYLACTIC AND THERAPEUTIC

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Gas gangrene is a condition which assumes considerable importance in military surgery but which has been relatively uncommon in civil practice. Of later years, however, it is being seen more and more frequently. To a certain extent its increasing occurrence in rural districts is due to more complete mechanization on the farms with a correspondingly greater incidence of severe mechanical injuries. Because of this fact and the high mortality with which it has been accompanied, any advance in the treatment of gas gangrene is significant. The vast experience obtained during the World War led to considerable progress in the treatment. Since that time the greatest advance has been in the use of serum, which was only in the developmental stage during the War. It is with our experience with the use of serum, both prophylactic and therapeutic, that this review is primarily concerned.

In 1932, a series of 18 cases of gas bacillus infection which had been treated were reviewed and presented at the seminar of the surgical department. This group represented all cases of gas bacillus infection which had been seen on the surgical service between the years 1926-1932. The mortality in this series was 50 per cent, which was no improvement over that of the A. E. F. Prior to this review, our treatment had been almost entirely surgical, and serum, both prophylactic and therapeutic, had received only slight attention. Because of the discouraging results in this group of cases, and influenced by the reports in the surgical literature regarding the use of polyvalent serum, the latter was introduced into the treatment of our patients. As 18 additional cases have been observed since the introduction of the serum into the treatment of gas gangrene in this hospital, an analysis of these two groups of cases seems warranted.

This analysis has attempted to answer the following pertinent queries:

(1) Has there been a decrease in our mortality rate which justifies the continuance of the use of serum?

(2) If so, is this due to the use of serum *per se*, or to other factors, such as a difference in the type of case which is complicated by gas bacillus infection?

(3) Is the continued use of prophylactic serum to be recommended?

(4) Has serum therapy made possible the use of less radical surgical procedures, such as the use of débridement in cases which would otherwise require amputation?

Before attempting to supply an answer to these questions a few important

points regarding the etiology and pathology are worthy of emphasis. While we commonly speak of the condition as a *C. welchii* infection, this is only a part truth. There is a fairly large group of anaerobes, the members of which have many characteristics in common, but with individual potentialities when implanted in living tissue. One organism may produce gas, another by putrefaction of tissue causes odor, while still another may cause edema. It is obvious then that the clinical evidence of infection will depend upon the particular etiologic agent and these manifestations may be modified by various combinations of organisms. One must be familiar with the manifestations of these various organisms and not depend upon any one feature of the condition, such as odor or gas, when making the diagnosis. A very striking example of this is presented by Ghormley<sup>1</sup> in which there is a brief account of a case characterized by edema and at no time was there gas in the tissues or an odor suggestive of gas bacillus infection. Cultures revealed *vibrio septique*.

TABLE I

## BACTERIOLOGY OF GAS GANGRENE

- (1) *Clostridium welchii* (*B. perfringens*, *B. aerogenes capsulatus*)  
The etiologic agent in about 80 per cent of cases
- (2) *Vibrio septique* (*Clostridium oedematis maligni*)  
Found in 10 per cent of cases
- (3) *C. oedematiens*  
Found in 3 per cent of cases
- (4) *C. histolyticus*
- (5) *C. fallax*

The anaerobic organisms may also be combined with pyogenic bacteria. The reports of the Surgeon-General state that the occurrence of *Streptococci* in symbiosis with the anaerobic group greatly increased the virulence of the infection, on the other hand the association of *Staphylococcus* seemed to produce less virulent infections than with anaerobes alone.

The anaerobes occur in the intestines of man and animals and in fertilized soil. The spores have been isolated from new woolen clothing and blankets. A consideration of the habitat of these organisms together with an understanding of the pathology present in gas gangrene permits us to predict the type of injury in which gas bacillus infection is likely to occur and provides some guidance as to the prophylactic measures which should be taken to prevent its occurrence.

Gas gangrene is essentially a disease of devitalized tissue, the favorite location being muscle which has been traumatized. The spread of infection tends to be in the long axis of the muscle rather than transversely from one muscle to another. Upon this conception of the pathology is based the rationale of debridement and excision of involved muscle as a means of avoiding amputation. However, in cases where the main blood supply to a part has been damaged, the entire limb may undergo a rapid massive gangrene. In such a case débridement is ineffective and amputation is a safer procedure.

The infected muscle tissue becomes brick-red in color, swollen and edematous, bleeding is less brisk than normal and there is a loss of muscular con-



tractility Later the muscle becomes lifeless and assumes a blackish-green appearance

The conditions suitable for the development of gas gangrene are most often found in severe lacerations and compound fractures In addition, there have been reported cases following operations on the biliary or intestinal tract, following delivery, after hypodermic injections, following catheterization, after gunshot wounds, and after amputations, particularly those which have been performed for arteriosclerotic or diabetic gangrene

These few points are briefly reviewed in order that we may be alert to prevent the development of a condition which has previously carried with it a mortality of 50 per cent This prophylactic treatment applies particularly to contaminated lacerations and compound fractures Prophylactic serum has been previously recommended as a preoperative procedure to be desired in amputations for diabetic and arteriosclerotic gangrene

In the previous report 18 cases were reviewed Two of these cases have been omitted from this report because a positive culture of *C welchii* was not obtained Clinically, however, these were definite gas bacillus infections, one of which died and the other lived

Positive *C welchii* cultures have been obtained on all cases reported in these two groups Cases presenting a positive culture, but with no clinical evidence of infection, have been omitted

TABLE II GROUP I (1926-1932)			
Number of Cases	Died	Recovered	Mortality Per Cent
16	8	8	50%

Table II represents the 16 cases occurring between the years 1926-1932

TABLE III GROUP II (1932-1936)			
Number of Cases	Died	Recovered	Mortality Per Cent
16	3	13	18%

Table III represents the cases occurring between the years 1932-1936

TABLE IV CONSOLIDATION OF GROUPS I AND II (1926-1936)			
Number of Cases	Died	Recovered	Mortality Per Cent
32	11	21	34%

Group II shows a substantial reduction in the mortality This, we believe, is due primarily to the therapeutic use of serum, there having been no other change in our method of treatment

In any such comparison of groups of cases, the type of injury which is complicated by gas gangrene must necessarily be considered It is well known that those cases in which there is considerable trauma and muscle damage present the more virulent and more fatal examples of the condition

A comparison of Tables V and VI shows a decrease in the incidence of compound fractures which are complicated by gas gangrene in the later series

TABLE V  
TYPE OF CASE COMPLICATED BY GAS GANGRENE (1926-1932)

	No Cases	Recovered	Died
Compound fracture tibia and fibula	3	3	0
Compound fracture humerus	2	1	1
Compound fracture radius	1	1	0
Compound fracture femur	1	0	1
Compound fracture metatarsals	1	0	1
Burn of legs	1	0	1
Typhoid perforation of ileum	1	0	1
Hypodermoclysis (thigh)	2	1	1
Leg amputation (diabetes)	2	0	2
Bismuth injection (buttock)	1	0	1

TABLE VI  
TYPE OF CASE COMPLICATED BY GAS GANGRENE (1932-1936)

	No Cases	Recovered	Died
Compound fracture forearm	2	2	0
Compound fracture tibia and fibula	2	2	0
Leg amputation (diabetes)	5	3	2
Fractured humerus with thrombosis of axillary artery	1	1	0
Leg amputation (A S)	1	1	0
Laceration (caused by rotary hoe)	2	2	0
Burns	2	1	1
Frost-bite (feet—bilateral)	1	1	0

It is our impression that this is to be explained by the more frequent use of prophylactic serum in compound fractures seen since 1932. The frequency of gas gangrene in amputation stumps, particularly in diabetics, has been pointed out by previous observers. We have had eight such cases, with a mortality of 50 per cent. Group I presents two cases of gas bacillus infection developing in the thigh following hypodermoclysis. One of these followed an interval appendectomy and resulted fatally. The second case followed drainage of an appendiceal abscess. This case responded satisfactorily to debridement of the involved area of the thigh.

It is obviously impossible to draw any conclusions from such a small series of cases as to the influence which type of injury exerts on the mortality rate. Despite the greater number of compound fractures in Group I, we do not feel that this is the entire explanation of the better results in the second series.

The smaller mortality rate in the second series is not due to any change in the surgical treatment of the condition. In both series of cases amputation has been performed much more frequently than débridement when the infection has involved an extremity. Debridement has, necessarily, been the procedure when the infection involved the trunk. Our opinion is, however, that the use of prophylactic and therapeutic serum will in the future make possible the use of less radical surgery. This does not mean that incomplete surgical attack combined with serum can cope with the infection, but merely that serum may permit the substitution of thorough debridement for amputation. Nevertheless, amputation will always have a place in the treatment of this condition. Each case must be individualized in arriving at a decision.

as to the surgical procedure which should be undertaken. Cases presenting interference with the main blood supply of an extremity will in most instances develop a massive gangrene and in these amputation rather than débridement should be performed. The degree of injury to an extremity may at times be sufficient so that amputation would be indicated even though gas bacillus infection were not present. Débridement, if it is performed, must be thorough, the standards upon which one bases a judgment as to the degree of involvement of muscle are its color, its contractility and the ability to bleed when it is cut. If amputation is performed, the level at which it is done and the type of amputation must receive consideration.

*The Value of Serum as a Prophylactic Measure*—Its value as a means of preventing gas bacillus infection cannot be definitely established at the present time. This information can be obtained only by inference after its use in a large series of cases of the type in which gas gangrene would be likely to develop. Of those cases which have had a prophylactic dose of serum we have no means of knowing how many would or would not have developed clinical evidence of infection if it had not been given. In Group I, no prophylactic serum was used. In Group II, one case developed clinical gas bacillus infection despite a dose of prophylactic serum.

**Case Report**—V. F. A male, age 36, was admitted to the hospital August 26, 1934. Three hours previously the wheels of a wagon passed over his right leg. Examination showed a compound fracture of the right tibia and fibula. There were areas of decreased density in the soft tissues suggestive of either gas or air. There was a ragged wound over the medial aspect of the tibia contaminated by dirt. He was given a prophylactic dose of combined gas bacillus (1,000 units perfringens, 1,000 units septique) and tetanus antitoxin (1,500 units). The wound was debrided, partially sutured, and a posterior molded plaster splint applied. In 12 hours he was complaining of severe pain in the leg. At this time inspection revealed no gas, odor or crepitus but considerable swelling. Temperature 98.6° F, pulse 100. The pain continued. Twenty-four hours following débridement and serum, the patient became irrational, temperature rose to 102.8° F, and pulse to 140. Inspection revealed the characteristic odor, crepitus extended three inches above the knee. Polyvalent serum (10,000 units) was given intravenously and a guillotine amputation was performed at the mid thigh. Polyvalent serum (10,000 units) was given eight hours later. Twenty-four hours after the thigh amputation crepitus could be elicited in the right buttock. Extensive débridement of all involved tissue was carried out. Therapeutic serum was given at eight-hour intervals, 21 doses being given during his illness. During convalescence crepitant areas developed over the elbow and shoulder from which *C. welchii* was recovered. A positive blood culture was never obtained. Convalescence was slow and skin grafting was necessary to cover the large granulating area on the buttocks. He was discharged from the hospital five months after the original injury.

Our experience with this patient, developing gas gangrene despite prophylactic serum, does not stand alone. Waitlin,<sup>2</sup> and also Ghormley,<sup>1</sup> give the impression that they have had similar experiences. These authors, as well as several others, felt that in those cases which do develop infection the disease is appreciably modified by the use of prophylactic serum.

We have not allowed this experience to disturb our faith in prophylactic serum. It is well known that clinical tetanus has developed despite prophylactic

lactic tetanus antitoxin Warthin recommends a second dose of prophylactic gas bacillus serum within 12 hours. This additional measure or perhaps an increase in the original dosage may be indicated.

**THE USE OF SERUM AS A THERAPEUTIC MEASURE**—The evaluation of therapeutic serum is more tangible. It has been shown that the chief difference between Groups I and II is in the more frequent use of therapeutic serum in the latter group. In Tables VII and VIII, the mortality of the cases having serum is compared to those treated without serum.

TABLE VII  
THERAPEUTIC SERUM GROUP I (1926-1932)

	No. Cases	Died	Recovered
Antitoxin given	2	0	2 (100%)
Antitoxin not given	14	8 (57%)	6 (43%)
Totals	16	8	8

TABLE VIII  
THERAPEUTIC SERUM GROUP II (1932-1936)

	No. Cases	Died	Recovered
Antitoxin given	14	2 (14%)	12 (86%)
Antitoxin not given	2	1 (50%)	1 (50%)
Totals	16	3	13

TABLE IX  
CONSOLIDATION OF GROUPS I AND II

	No. Cases	Died	Recovered
Antitoxin given	16	2 (12%)	14 (87%)
Antitoxin not given	16	9 (56%)	7 (44%)

A comparison of the two groups shows a mortality of 12 per cent in those cases having serum as contrasted with a 56 per cent mortality in cases treated without serum.

The number of injections given in our cases has varied from 1 to 21, the majority of cases having but one or two doses. Ghormley observed that those patients who react favorably to the serum do so after one dose has been given. This has also been our impression. We believe, however, that the serum should be repeated every four to eight hours as long as there remains evidence of infection, as manifested by elevation of temperature, increased pulse, mental clouding or local signs. The intravenous method of administration is preferred.

There has always been considerable discussion as to the relative efficacy of the various chemicals used as local applications. Hydrogen peroxide, quinine solutions and Dakin's solution have had their advocates. For the most part we have used hydrogen peroxide. It seems doubtful if it makes any material difference if such solutions are used or not. Adequate surgery, therapeutic serum and the avoidance of occlusive dressings are the essentials.

*Present Method of Treatment*—Prophylactic. A knowledge of the type of injury or condition which is most likely to be complicated by gas bacillus infection is the first essential. Compound fractures and lacerated wounds which are contaminated have been the chief offenders. In such cases

a thorough mechanical débridement removes the devitalized tissue. If the wound is left open an aerobic environment is provided which is a further hindrance to the growth of the anaerobic organisms. In such cases the giving of gas gangrene antitoxin should be as much a routine as the giving of tetanus antitoxin. For this the combined gas gangrene and tetanus antitoxin should be used. This contains 1,500 units of antitetanic serum and 1,000 units each of *C. welchii* and vibriion septique antitoxin.

Direct smears from the wound may show the organism. This does not necessarily mean an infection, as it is well known that the organisms may be present without clinical evidences of infection ever developing.

The use of prophylactic serum is particularly recommended as a pre-operative measure for patients who are to undergo amputation for arterio-sclerotic or diabetic gangrene. Such cases have made up 25 per cent of our cases of gas gangrene. In this special group there has been a 50 per cent mortality.

TABLE X  
CASES OF GAS GANGRENE IN AMPUTATION STUMPS

	No. Cases	Died	Recovered
Antitoxin given	4	1	3
Antitoxin not given	4	3	1

*Diagnosis*—In the typical and advanced case the diagnosis can hardly be missed. The odor, the crepitus, the muscle and skin discoloration, are findings too evident to allow even the most careless observer to ignore them. Gas in the tissues may often be demonstrated by percussion much earlier than crepitus can be elicited. The finding of gas in roentgenographic study may also be a considerable aid in making an early diagnosis. One must remember that the finding of such areas in the soft tissues may be due to entrapped air and be independent of gas bacillus infection.

Early diagnosis of the condition is imperative if treatment is to be effective. More pain than should normally occur from the injury or operation is one of the earliest signs. An increasing pulse rate is of more significance than the temperature, which may not be markedly elevated. In a considerable number of our cases the patients have been irrational.

Treatment of the clinical infection consists of a judicious combination of surgery and serum. All involved tissue is removed either by débridement or amputation, as conditions demand. The wound is either left open to the air or a light dressing saturated with hydrogen peroxide is applied. Therapeutic doses of polyvalent serum are given either intramuscularly or intravenously at intervals of four to eight hours until there is a satisfactory response. The local area is watched carefully for evidence of recurrence of infection, and if this develops it is treated accordingly. Blood transfusions are an important part of the treatment because of the rapid hemolysis which not infrequently takes place.

Irradiation therapy has been recently advocated as an auxiliary method of treatment. This, however, has not been used in the group of cases cited, but

in the future it will be given a thorough trial. We expect that it will have its greatest applicability in those cases in which there is an associated Streptococcus infection. This expectation is based on the excellent results which we have observed when it has been used in the treatment of erysipelas and other Streptococcic infections.

Five additional cases have been seen during the past year by my associate, Dr F W Foirdyce, and myself. These cases were not seen by us until after a definite gas bacillus infection was present. A brief summary of these cases is presented.

TABLE XI

	Sex	Age	Injury	Prophy- lactic Serum	Opera- tion	Thera- peutic Serum	Roentgen Therapy	Result
1	F	10	Laceration of leg	Yes	Debride- ment	Yes	Yes	Recovery
2	M	9	Laceration of leg	Yes	Amputa- tion	Yes	Yes	Recovery
3	M	9	Cmpd frac of humerus	No	Amputa- tion	Yes	Yes	Recovery
4	M	37	Laceration of arm	No	Débride- ment	Yes	Yes	Recovery
5	M	9	Laceration of leg	No	Débride- ment	Yes	Yes	Recovery

This group is of interest inasmuch as two cases developed gas bacillus infection despite the use of prophylactic serum. They present additional evidence that prophylactic serum without intelligent surgery cannot be expected to prevent the development of gas gangrene.

## CONCLUSIONS

(1) In a group of 16 cases of gas gangrene treated without serum the mortality was 50 per cent. In a group of 16 cases in which serum was an essential part of the treatment, the mortality was 18 per cent.

(2) Prophylactic antitoxin should be used in all wounds potentially infected by gas bacilli. The occasional case which develops gas gangrene, despite prophylactic serum, does not prove its inefficacy, but does suggest that an increase in prophylactic dosage, or an early repetition of the injection, may be advisable.

(3) Prophylactic serum should be given preoperatively to patients who are to undergo amputation for diabetic or arteriosclerotic gangrene.

## REFERENCES

- <sup>1</sup> Ghormley, R. K. Gas Gangrene and Gas Infections. Jour. Bone and Joint Surg., 17, 907.
- <sup>2</sup> Warthin, H. J. Gas Bacillus Infections. Virginia Med. Month., 62, 276.
- <sup>3</sup> Medical Dept of U. S. Army in World War, 11 and 12.
- <sup>4</sup> Elliot, E. Gas Gangrene. ANNALS OF SURGERY, 101, 1393.
- <sup>5</sup> Millar, W. M. Gas Gangrene in Civil Life. Surg., Gynec., and Obstet., 54, 232.
- <sup>6</sup> Stone, C. S. Diagnosis and Treatment of Gas Bacillus Infection. Virginia Med. Month., 61, 200.
- <sup>7</sup> Kelly, J. F. The X-ray as an Aid in the Treatment of Gas Gangrene. Radiology, 20, 296.
- <sup>8</sup> Zimsser. Textbook of Bacteriology, 7th edit. D. Appleton Co.

# A CORRELATION OF ROENTGEN RAY DOSAGE AND NECROPSY FINDINGS IN A CASE OF RETROPERITONEAL AND MEDIASTINAL METASTASES FROM EMBRYONAL CARCINOMA OF THE TESTIS

DEATH FROM GANGRENE OF THE COLON, THE RESULT OF IRRADIATION THERAPY

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THE value of irradiation in the treatment of malignant testicular neoplasms has long been recognized because such neoplasms usually exhibit a high degree of radiosensitivity. However, there is little evidence to indicate what might be regarded as an adequate "carcinomacidal dose" for these tumors. The following case history is presented because it is an instance of extensive, deeply seated metastases from such a neoplasm, that were clinically controlled for 18 months, with necropsy at the termination of this period following death from intercurrent disease, permitting an histologic study of the effects of the irradiation. In the literature there are few reports of necropsy findings in patients with deeply situated malignant tumors who were clinically well from the disease as a result of external irradiation. In the present state of knowledge concerning the reaction of malignant neoplasms in vivo to irradiation, cumulative reports of this nature would contribute to the advance of irradiation therapy.

**Case Report**—W K (103384), white, male, age 40, mechanic, admitted to the University of Chicago Clinics May 2, 1934, complaining of general weakness and presenting a large nodular, slightly tender mass, 12 cm in diameter, situated in the upper right quadrant of the abdomen and extending to the left across the midline. The mass does not move with respiration and gives the impression of being attached to the posterior abdominal wall. Wassermann and Kahn negative. Urinalysis, negative. R B C 4,140,000. W B C 7,500. Hb 61 per cent.

In August, 1932, in another hospital, the right undescended testicle was removed for a malignant tumor. Opportunity was afforded to study the sections made in 1932 of the testicular neoplasm. It is composed of large solid masses of rounded cells with indefinite cytoplasmic outlines (Fig 1). The nuclei are round or oval, hyperchromatic, and contain one or more nucleoli. There are many mitotic figures. There is very little stroma. **Histologic Diagnosis**—Embryonal carcinoma (seminoma) of the testis.

Roentgenograms of the chest show a rounded mass approximately 9 cm in diameter which stereoscopes in the anterior superior mediastinum (Fig 2).

**Clinical Diagnosis**—Retroperitoneal and mediastinal lymph node metastases from previously removed embryonal carcinoma of the right testicle.

**Treatment**—Beginning May 5, 1934, and ending June 8, 1934, the patient received irradiation as indicated in Chart 1. A moderately severe erythema developed on the anterior abdominal port followed by pigmentation and dry scaling. The reaction was

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milder on the posterior abdominal port      There was moderate erythema followed by  
slight pigmentation on the thoracic ports      By the end of June roentgenograms showed

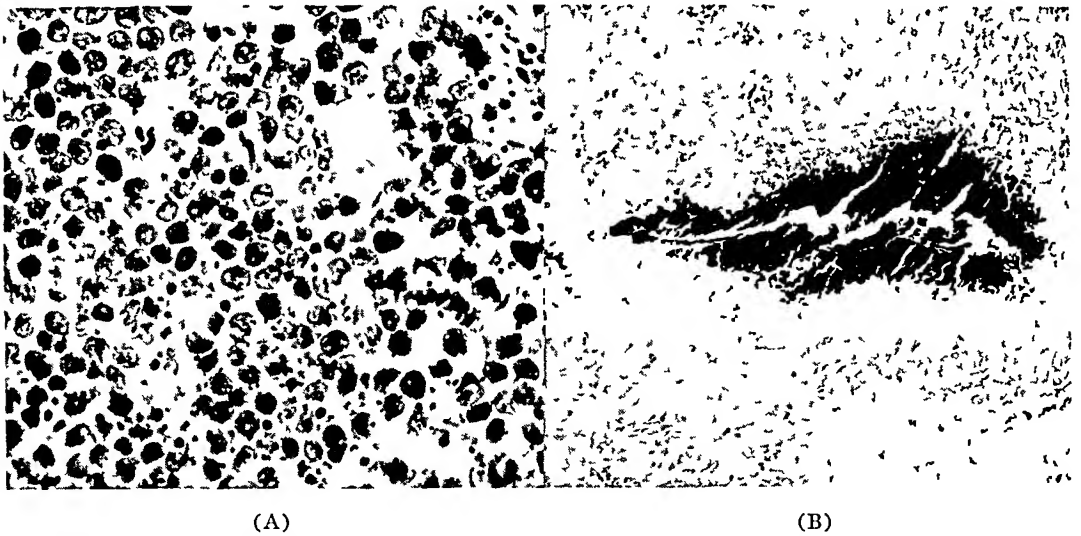


FIG 1—(A) Photomicrograph (X500) of section of embryonal carcinoma of right testis removed August, 1932. (B) Photomicrograph (X140) of section of one or two small necrotic nodules found in the upper retroperitoneal space at necropsy 18 months after irradiation therapy for large metastasis in this region. Only faint "shadows" of tumor cells are seen. The dark mass represents calcification about a necrotic vessel. No viable neoplastic cells are found.

marked regression of the mediastinal mass. The abdominal mass had also decreased about one-third in size.

During August, 1934, the patient's condition continued to improve, there were increased strength, good appetite, no pain and gain of 16 pounds in weight. In Novem-

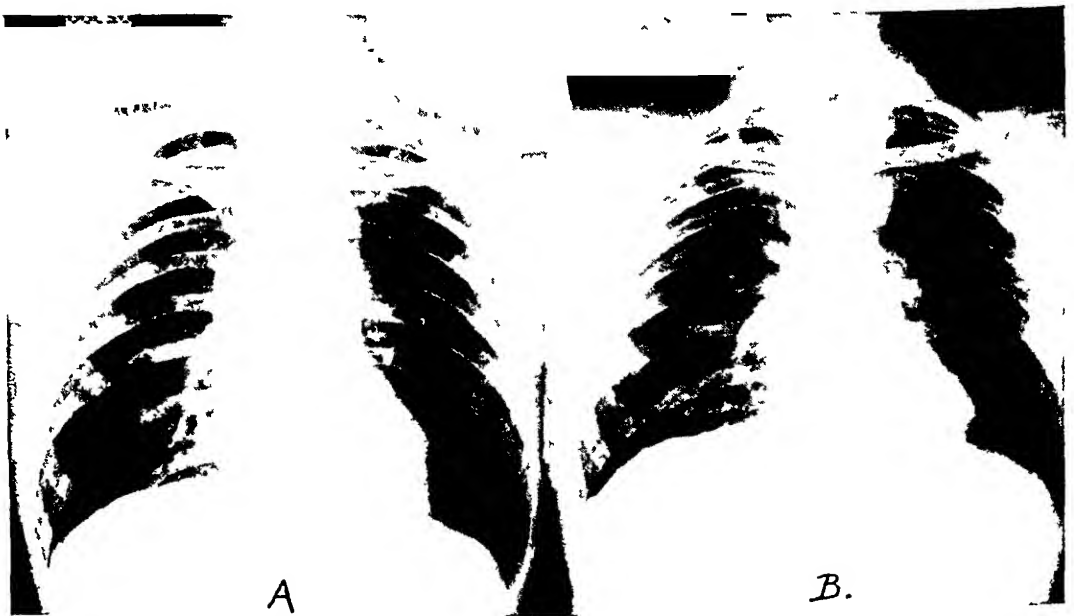


FIG 2—(A) Roentgenogram of chest on admission May 11, 1934, showing large tumor mass in upper mediastinum. (B) Roentgenogram of chest taken November, 1935, showing complete regression of the mass. At necropsy no neoplastic cells, living or necrotic, were found in the mediastinum.

ber 1934 he complained of severe upper right quadrant pain related to eating. Cholecystograms showed visualization of the gallbladder without stones.

By March, 1935, the abdominal mass could not be palpated and roentgenograms of the chest made in April, 1935, showed complete regression of the mediastinal tumor.



## EFFECTS OF IRRADIATION

The skin in the anterior abdominal portal was now firm, indurated, leathery and presented small scattered areas of pigmentation and telangiectases

During the summer and early fall of 1935 there were no complaints. However, on December 16, 1935, the patient was readmitted to the hospital in very poor general condition, complaining of paroxysms of upper abdominal cramps, rhythmic in character, followed by periods of relief. These paroxysms had occurred at intervals for nine days and were sometimes accompanied by vomiting of bile. Examination of the abdomen revealed some distention and generalized tenderness, deep palpation of the upper abdomen was not satisfactory because of the dense sclerosis of the skin in the irradiated field, giving a board like consistency to the abdominal wall. Temperature 98° F. Pulse 100. WBC 20,000. Roentgenograms of the abdomen revealed distention of the small bowel by gas and multiple fluid levels suggestive of low small bowel obstruction.

*Clinical Impression*—Obstruction of the small bowel, lower portion probably secondary to recurrence of retroperitoneal metastases.

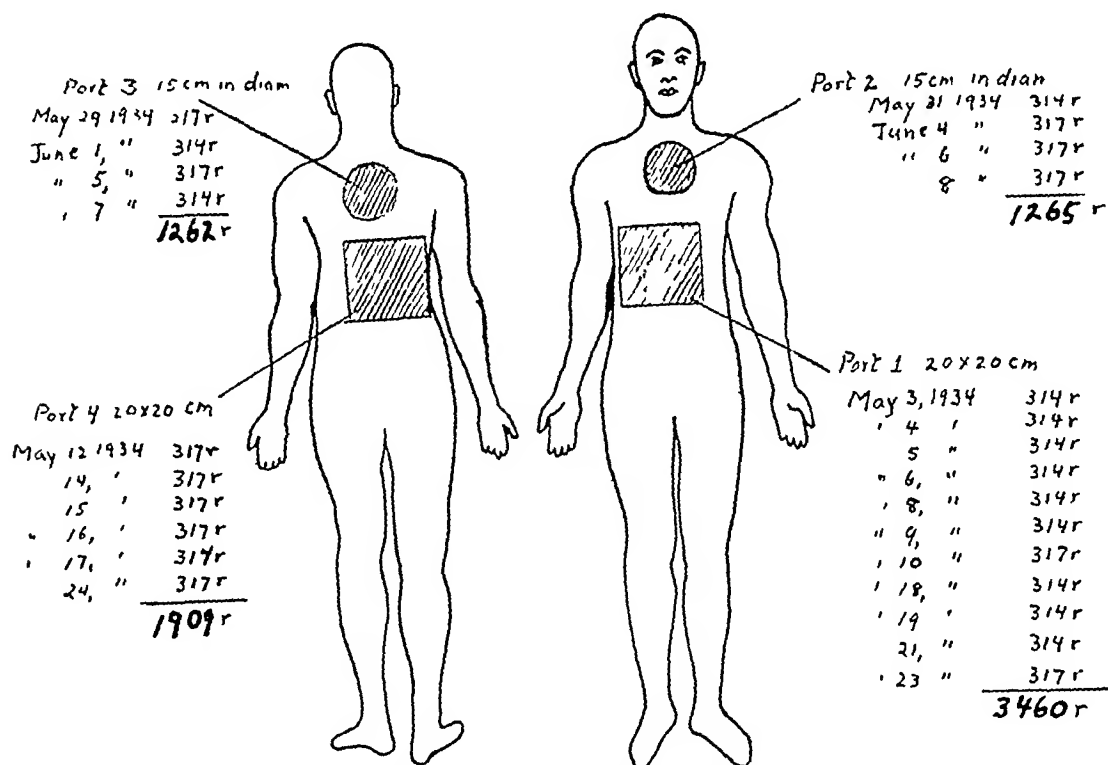


CHART 1—Detailing amount of roentgen therapy administered in case cited. Factors 200Kv, 25Ma, FSD 50 cm. Filtration 1/4 Mm Cu and 2Mm Al. Irradiation delivered at approximately 40r per minute. Total period of treatment 36 days. Estimated "tumor dose" to mediastinal lesion 1,094r. Estimated "tumor dose" to abdominal lesion 2,326r.

*Operation*—After a brief period of symptomatic improvement due to restricted intake by mouth and hypodermoclyses, the patient was operated upon December 27, 1935, with the intention of relieving the obstruction. The abdomen was entered through a right paramedian incision, retraction of the wound margins was quite difficult because of the dense sclerosis of the skin and subcutaneous tissues. Findings: Diffuse fibrous peritonitis, torsion of a terminal loop of ileum without gangrene but with involvement in a dense mass of adhesions that surrounded the first portion of the transverse colon, gangrene of the segment of transverse colon, three inches long, that was included in the mass of adhesions just described. The torsion of the ileum was reduced and the gangrenous segment of transverse colon lifted easily out of the abdomen. It appeared almost sequestered from attachments to viable colon on either side. The gaping portions of remaining colon could not be mobilized because of the dense adhesions. The distal segment was invaginated and an ileocolostomy (side-to-side) performed. A glass Paul tube was inserted into the proximal segment and after placing gauze packs about

it, the abdominal wound was partially closed. The patient died on the sixth day post-operative with clinical signs of generalized peritonitis.

*Necropsy*—There was a generalized fibrinopurulent peritonitis, but no evidence of leakage about the ileocolostomy. There was no gross or microscopic evidence of neoplasm in the mediastinum. In the upper retroperitoneal space two small caseous masses 2 cm in diameter, grossly suggestive of lymph nodes containing necrotic neoplasm, were found. On microscopic examination one proved to consist of a finely granular acellular material, the other was found to be composed of a mass of neoplastic cells which had undergone complete coagulation necrosis, only "shadows" of some of the neoplastic cells remaining with scattered foci of calcification (Fig 1). No viable tumor cells were found here or elsewhere. Microscopic examination of the necrotic segment of colon removed at operation showed no evidence of neoplasm. The gross and microscopic findings about the site of the removed gangrenous segment of the colon did not indicate that this necrosis was merely the result of a thrombophlebitis. It appeared to be a part of the chronic inflammatory process induced by the irradiation not only in the viscera but in overlying skin and subcutaneous tissues.

*Discussion*—The necropsy findings show that the metastatic neoplasms had apparently been controlled by the amount of irradiation administered. Thus, evidence is presented (one case) to indicate that tumor doses of 1,000 R to 2,400 R, delivered in divided doses over a period not exceeding 36 days and with an intensity of approximately 40 R per minute, might be effective in controlling deeply seated metastases from radiosensitive embryonal carcinoma of the testis. These doses are substantially less than those which experience has shown to be the optimum doses necessary to control squamous cell carcinomata of the buccopharyngeal cavity, *i e*, 4,000 R to 4,500 R.

The above patient died of a complication resulting from irradiation, namely, late gangrene of the segment of colon included in the abdominal portals. It is not possible to state exactly the mechanism of production of this gangrene. The history and findings at operation indicate that it was not an acute lesion but was a process that had developed progressively for some time prior to the onset of acute symptoms. In all probability several factors were concerned, namely, a slowly progressing ulceration of the bowel mucosa, a slowly increasing vascular impairment and superimposed upon these a spreading infection from the bowel contents.

It may also be pointed out that the dense sclerosis in the skin and subcutaneous tissues of the anterior abdominal port were well established several months before there was clinical evidence of underlying visceral injury.

Somewhat similar complications in the stomach and ileum have been reported by Elliott and Jenkinson<sup>1</sup> in a patient suffering from abdominal Hodgkins' disease, who received a total surface dose of 2,180 R in nine sessions to the anterior and posterior abdomen over a period of nine months. Seven weeks following the last treatment the patient was hospitalized for abdominal pain which was increased by eating. Exploratory laparotomy was performed at which time peritonitis was observed and an inflamed appendix removed. Five days later the patient died and at necropsy three large and several small ulcers were found in the stomach, the largest of the former, measuring 9 x 12 cm, had perforated. There were also patches of circular

ulceration in the ileum These authors attribute the ulcerations to the irradiation and not the disease Jones<sup>2</sup> pointed out that while acute intestinal injuries following irradiation are numerous, the chronic forms appear, until the present at least, to be uncommon He cited seven known cases of benign stricture of the small bowel from among 520 patients with cervical carcinoma who were treated by local implantation of radium and external roentgen therapy

One of us (A B) has observed a localized severe inflammation in the sigmoid colon adjacent to a chondrosarcoma arising in the region of the left sacro-iliac joint and in the treatment of which approximately 20,000 R (surface dose in air) had been delivered at intervals over a period of 28 months The symptoms of pain, tenesmus and bloody diarrhea developed 28 months after the onset of treatment and subsided after 16 weeks The patient is still living five years and two months after beginning treatment and has no marked symptoms referable to this complication Pressure from the slowly growing chondrosarcoma may have been a contributing factor to the production of the bowel lesion

It must be emphasized that the outcome in the case reported in detail above should not be construed as indicating that in order to control such neoplasms it is necessary to employ doses that will ultimately prove lethal to the patient The fatal termination in this instance was due to the fact that this patient belonged to the relatively small group of individuals whose normal tissues do not well tolerate irradiation Experience has shown that the large majority of patients will tolerate the amounts of irradiation delivered in the case cited without serious difficulty

#### SUMMARY

A patient presenting large upper abdominal and mediastinal metastases from a previously removed embryonal carcinoma (seminoma) of the testicle received "tumor doses" of 2,326 R and 1,094 R (roentgen radiation), respectively, to the lesions, over a total period of 36 days The patient died 18 months later of gangrene of the segment of transverse colon included in the irradiated area of the abdomen due presumably to the irradiation At necropsy no evidence of neoplasm was found in the mediastinum and only two small masses (2 cm in diameter) of necrotic neoplastic cells were found in the upper retroperitoneal space No viable neoplastic cells were found elsewhere

The unfortunate outcome in this case is explained on the basis that the patient was one of those whose normal tissues do not well tolerate irradiation Experience has shown that the majority of patients will tolerate, without permanent injury, the doses administered in the case described

#### REFERENCES

- <sup>1</sup> Elliott, A R, and Jenkinson, E L Radiology, 23, 149, 1934  
<sup>2</sup> Jones, T E Am Jour Obstet and Gynec, 29, 309, 1935

# TISSUE HEATING ACCOMPANYING ELECTROSURGERY

AN EXPERIMENTAL INVESTIGATION

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THE GROWING prevalence of the use of high frequency currents in the resection of excess tissue has led to recent investigations<sup>1</sup> concerning the possible harmful effects of the heat generated by these currents in the vicinity of their application. These investigations have been based upon temperature measurements made with thermocouples inserted into the tissue at the point where dangerous temperatures might be produced and have indicated undesirable heating.

The use of thermocouples for such measurements has possibilities of giving results differing widely from correct values unless certain precautions are taken to avoid spurious heating of the thermocouples themselves. Since previous investigations have not dealt adequately with these difficulties and their elimination, it seemed advisable to determine the magnitude of these errors and to make measurements with the necessary precautions.

The production of the various kinds of high frequency currents and their respective advantages for surgical uses as well as for deep heating by diathermy are ably considered in the literature<sup>4</sup>, that by Hemingway and Sensation details a convenient and inclusive summary.

Before taking up the discussion of the experimental work it is well to have in mind certain characteristics of the behavior of the high frequency currents in present day surgical use (frequencies from 500,000 to 3,000,000 cycles). We are here interested mainly in their characteristics under certain special conditions: first, the behavior of the currents in the tissues themselves, and, second, the behavior with respect to any foreign bodies that may be present in the tissue—the measuring instrument, for example.

*Behavior in Tissue*—The experimental work of McClendon<sup>5</sup> has shown that the cell behaves with respect to the high frequency current as if it were a small bit of salt solution surrounded by a good, but very thin, insulator, the whole immersed in another conducting fluid. This makes the electrical equivalent of the cells immersed in body fluid a circuit of small condensers, shunted by, and in series with, small resistances (Fig 1).

Since condensers offer great resistance to the passage of electric currents of low frequency and but little resistance to currents of very high frequency, it is natural to expect the body fluids to carry most of the current until the frequency becomes high enough for the small condensers of the cells to allow it to pass. Also, as the frequency increases, the total resistance of the tissue

should decrease until the resistance of the condensers (reactance) becomes small in comparison with the resistance of the fluids. Then a further increase in frequency should not alter conditions appreciably because the only resistance left is that of the fluids, which is not affected by changes in frequency. The work of McClendon verifies this also.

As has been mentioned before, whenever an electric current flows in a resisting medium, heat is produced. The amount of this heat is proportional to the resistance, to the time the current flows, and to the square of the current density. Christie and Loomis<sup>6</sup> have shown that the heat generated can all be accounted for by considering the electric circuit similar to that mentioned previously. Electrical theory shows that, under the conditions in which the cutting loop is employed, the heating in the tissue should fall approximately as the fourth power of the distance from the loop, for small distances in an homogeneous medium.\* The fact that the loop moves with varying speed while cutting and that cutting is done under water in tissues that are nonhomogeneous makes it practically impossible to use the law for

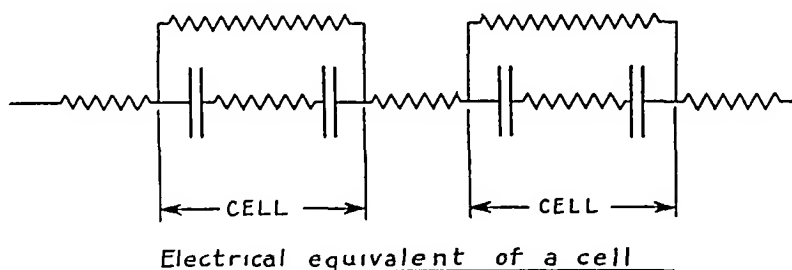


FIG. 1

more than an indication of what to expect. It tells us that, if the temperature rises by one degree at a distance of one centimeter, it ought to increase by 16 degrees at one-half centimeter, 256 degrees at one-fourth centimeter, and so on.

The mention of nonhomogeneity of the medium immediately raises the question as to what paths the current should follow in the body. High frequency currents tend to travel on the surface of good conductors,<sup>7</sup> but Richardson<sup>8</sup> has shown that the body is too poor a conductor for this to take place. The work of Grover<sup>9</sup> shows that the resistances of the various tissues range from dry skin rated at 100 to blood rated at 2, with muscles and glands rated at 20 and 25 respectively. He adds that variations of 300 per cent may be expected when going from individual to individual. However, recent experi-

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\* The electrical theory of the current distribution between a small sphere and an infinite plane in an isotropic medium shows that the current density varies inversely as the square of the distance from the center of the sphere for distances small compared to the distance between the sphere and plane. Since the loop is not a sphere nor yet a point electrode, the distribution will not assume the theoretical relation in its immediate vicinity but will approximate it in a small region whose distance from the loop is great enough to overcome the effects of its shape, but not great enough to be beyond the range of the inverse square distribution.

For this reason actual measurements of distribution and time rate of change of temperature were made with a small spherical electrode imbedded in the tissue.

ments do not verify this great variability. The general conclusion is that currents will tend to avoid fat, bone, and cartilage and, when forced to penetrate these, they will do so with a greater temperature rise. The wise technician will so locate his electrode as to avoid this as much as possible.

However, the variation in resistance between types of tissue should make but little difference in deep heating in a fairly homogeneous medium. In a tissue of greater resistance less current will be needed to raise the temperature at the loop to the cutting point and the heating at a distance will be correspondingly less. This assumes that there is no constant resistance, irrespective of tissue, such as contact resistance at the loop. The doubts relative to the true nature of the mechanism of cutting at the present time indicate that this is a good question for investigation, especially when one considers the fact that currents of equal heating effect, as shown by a thermocouple ammeter, differing widely in spark frequency but not greatly in radio frequency, differ greatly in their cutting ability. In any case the spark frequency is so great that it is impossible for the heating of the cells to follow the changes any better than the ammeter. This leads one to believe that some other phenomena must be involved in the different effects of these currents, a change in power factor for instance.

*Effects of Foreign Bodies*—The effects of high frequency currents on foreign bodies, which are of interest here, are two: eddy current heating and electrostatic pick-up.

When currents of high frequency flow around a conductor, they set up currents within the conductor by reason of their magnetic fields. These local currents circulating inside the conductor serve to heat it and in the case of a thermocouple might cause an erroneous reading.

To the person not acquainted with high frequency currents electrostatic pick-up is a most perplexing phenomenon. Those who are accustomed to the ordinary lighting current know that touching one wire of the circuit causes no trouble as long as they are insulated from the other; it is necessary to complete the circuit between the two in order to get a shock. When a person, otherwise insulated, points his finger at the active electrode of a high frequency generator and draws to himself a painful spark, he immediately wonders how that could happen. The explanation is simple.

Any body has what is called electrostatic capacity just as an air tank has what is called air capacity. That is, it requires a certain amount of electricity to charge the body up to a given electric pressure just as it requires a certain amount of air to charge the tank up to a given air pressure. If the air tank in this illustration were a toy balloon and the reader attempted to blow it up and let it collapse once each second, he would soon realize that a good bit of air had passed in and out of his lungs and that he was working rather hard without leaving any great amount of air in the balloon. So it is with high frequency currents. When a body is connected to the active electrode of a high frequency generator, the generator immediately starts to charge it up and discharge it some millions of times each second. It requires a rather large

current to do this, depending, of course, upon the capacity of the body and the rapidity of the changes. This current is the analog of the air flowing in and out of the bladder in the previous example and the heat producing the burn is the analog of the work done in keeping the air moving into and out of the bladder.

Also, every body forms one plate of a small condenser with the earth as the other plate and the air between as the dielectric. It will be remembered that condensers offer small resistance to high frequency currents. Thus some of the current to the body is flowing through this condenser.

From the foregoing it is evident that the foreign bodies introduced into the tissue to measure the temperature may be warmed by eddy currents set up

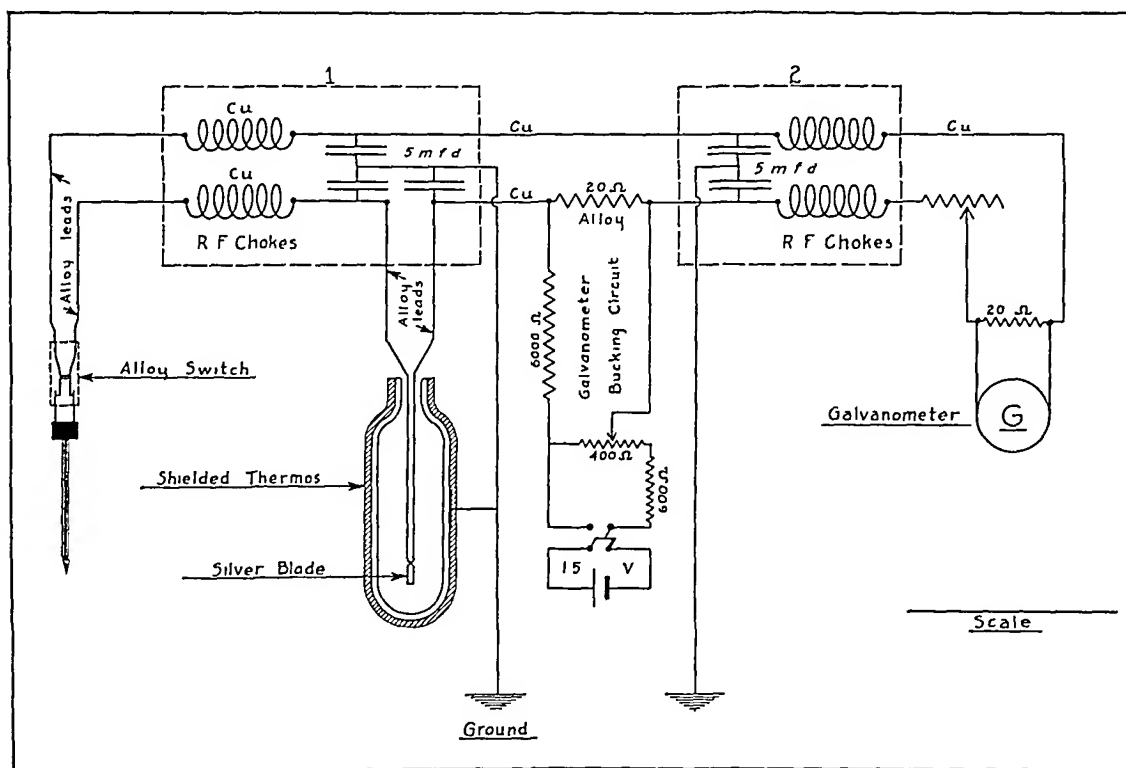


FIG 2—Schematic diagram of temperature measuring equipment

within them or by the current they draw to themselves by reason of their electrostatic capacity and that of the apparatus to which they are attached. These effects have been investigated in detail.

**DESCRIPTION OF APPARATUS—Measuring Circuit—**The temperature measuring circuit was the usual set up for measuring temperature by means of thermocouples, with certain modifications as necessity demanded. The circuit as finally used is shown in Fig 2. The chokes and condensers within the dotted areas 1 and 2 served to block the high frequency current from parts of the apparatus where it was not wanted.

**Thermocouples—**The thermocouples used for measuring the temperatures consisted of two strands of No 28 wire, one of alumel and the other of chromel, run through a pyrex tube 2 Mm in diameter and 10 cm long (Fig 3A). The two wires were insulated by encasing one of them in a tiny pyrex

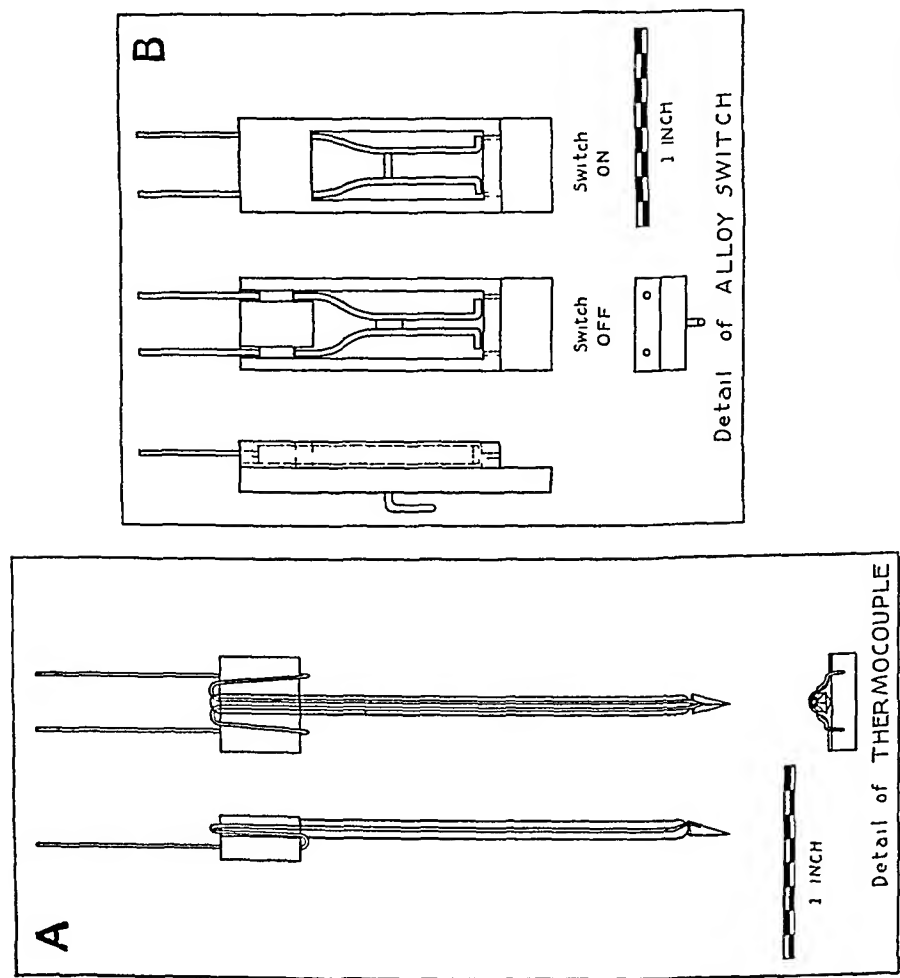
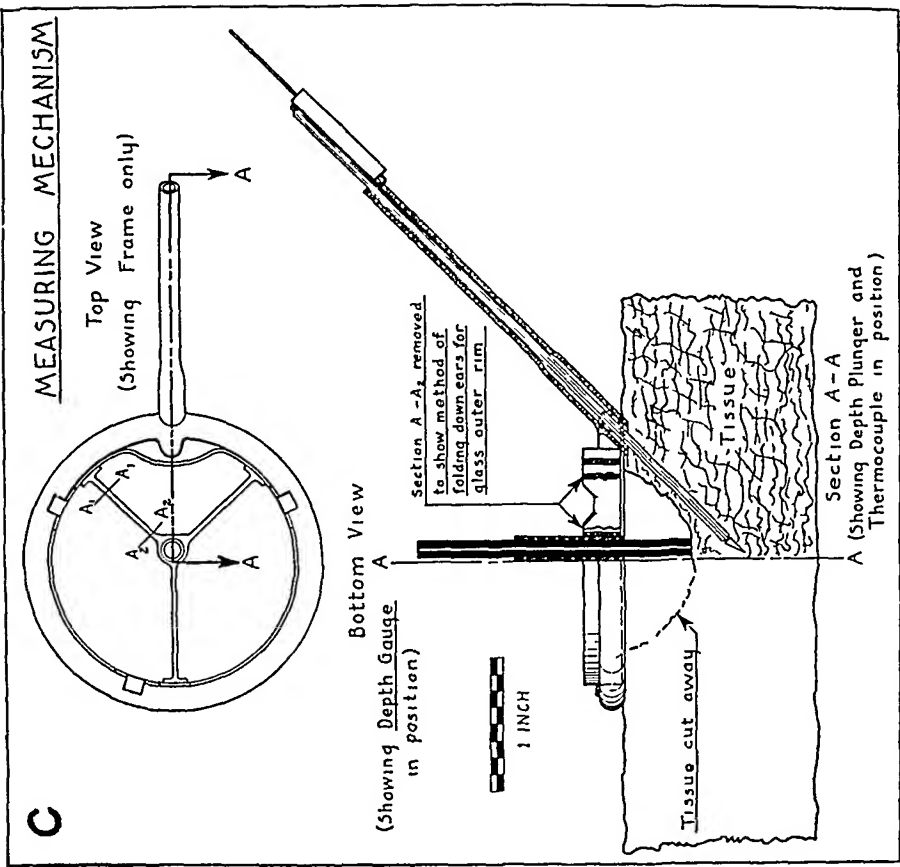


Fig 3 —Thermocouple construction, connection, and location



sleeve just large enough to slide over the wire. The outer tube was then collapsed upon the leads by heating. This left a stem  $1\frac{1}{2}$  Mm in diameter with the wires sealed in. The junction was made by fusing the two wires and then silver soldering to the various tips as mentioned later. The leads were spot welded to No. 22 wire of the same alloy anchored in a small hard rubber plug. This was made to fit into an all-alloy low capacity switch as shown in Fig. 3B. The cold junction was made in the same manner but with larger tubing and the tip was silver soldered to a silver blade 5 by 8 by  $\frac{1}{2}$  Mm for reasons mentioned later. The cooling bath was a pint Dewar flask.

*Chokes*—The chokes were of the pie-wound low loss type and proved quite effective on the vacuum tube current but much less so on the spark current.

*Measuring Gauge*—Probing was found to be very unsuccessful in determining distances to the couples from the cut surface thereby necessitating a measuring gauge (Fig. 3C). A pyrex ring 5 cm in diameter with a slanting tube sealed to one side to serve as a guide for the couple was constructed as shown. The depth gauge for use in determining the distance from cut to couple tip was so constructed as to use the glass ring for a measuring base. In use the ring was held firmly on the surface of the tissue and the couple inserted through the guide tube. The tissue was then cut away as shown in Fig. 3C by making progressive cuts across a plane parallel to that of the ring. To gauge the distance to the couple it was only necessary to snap the depth gauge onto the ring and make the measurement by obtaining the distance to the cut surface and subtracting from the known distance to the couple. In the following data the distance from the couple in a series of cuts always means the shortest distance from the couple to the plane of the series of cuts. The error in measuring distances under 1 cm is about 10 per cent. This is due to the distortion of the tissues during the cut, their subsequent slight compression during measurement, and to the length of the tip. The gauge readings are accurate to  $\frac{1}{4}$  Mm. Even this considerable error is a large improvement over the errors introduced by the displacement of couple and tissue when searching with a probe.

*STUDY OF ERRORS*—The following errors that may arise in using an apparatus of this sort, when used as shown in Fig. 2, were investigated. The occurrence of each error and the means of elimination when necessary are shown for each case as it is discussed.

*Stray Electromotive Forces*—Whenever two dissimilar metals meet in the circuit there will be an electromotive force set up that will vary with any change in temperature at that point. They are in effect additional thermocouples. Since we are using the apparatus to measure temperature differences only, it is not necessary to avoid long time changes of these electromotive forces. So long as they do not vary while a single temperature difference is being measured they can be disregarded. With the couples inserted in constant temperature baths, the instrument was watched for any change. None of detectable value was observed in the length of time required to measure

the temperatures desired. Nor was there any measurable effect when the high frequency generator was used in the immediate vicinity of the equipment. The alloy switch mentioned earlier prevents errors arising from the heat of the hands.

*Heat Capacity of Couples*—In view of the rather poor heat conductivity of tissue it is possible that the heat capacity of the tip may cause its temperature to lag behind that in the tissue. The low specific heat of the materials involved makes this seem unlikely. By experiment it is found that the time required for the galvanometer to reach equilibrium is the same when the couple is connected to it before inserting into the tissue as when the couple is connected after being in the tissue for some time. This would not be the case if the couple were lagging in temperature.

*Galvanometer Lag*—The period of the galvanometer used was 4.5 seconds on open circuit. When connected to its critical damping resistance six to seven seconds were required for the instrument to indicate the reading after connection to a couple already in equilibrium with its surroundings. The sudden temperature changes found when working within about 3 Mm of the cutting loop are such that the instrument is unable to follow them. The cooling of the tissues before a reading is indicated would make it considerably low. Since a galvanometer capable of following the rapid changes was not available, the experimental work was confined to regions where this error would not be appreciable.

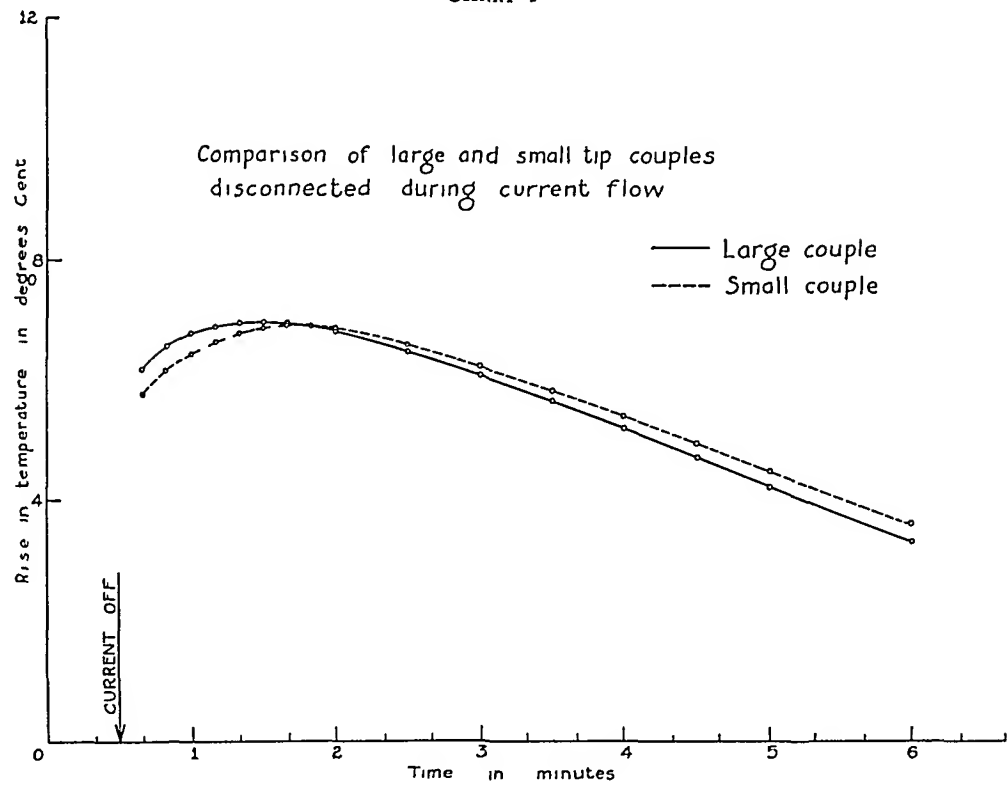
*Heat Used by Thermocouple*—The electric current generated by a thermocouple arises at the expense of heat absorbed at the junction of the metals. A computation, based on Bridgeman's<sup>10</sup> thermodynamic analysis of thermocouples shows that the temperature gradient necessary to supply this heat is negligible. This is verified by the fact that couples with tips of different sizes indicate the same temperature in the tissue.

*Suspension Distortion*—The most desirable method of studying the temperature change during a cutting series is to have the measuring circuit connected at all times during the work. It was found that, for galvanometer deflections of 30 to 40 cm, the suspension became permanently twisted. The twist increased with time, amounting to about 0.6 cm in the course of 30 minutes. The bucking circuit was arranged as shown in Fig 2 in order to allow the cold junction to be held at zero degrees and always have the galvanometer start from zero for a set of readings. A series of tests showed that the distortions on the small displacements encountered when used thus were of no significance.

*Eddy Current Heating*—Thermocouples with tips of assorted sizes ranging from a pair of twisted No. 28 wires 2 Mm long to a brass plug 5 by 10 Mm were inserted into the same spot in a piece of beef. Couples were disconnected while current was flowing. The size of tip made no difference greater than the experimental error of  $2^{\circ}$  as determined by check runs to find the effect of withdrawal and insertion of the couples. Data were taken also for the strong fields in the neighborhood of an 8 Mm brass sphere elec-

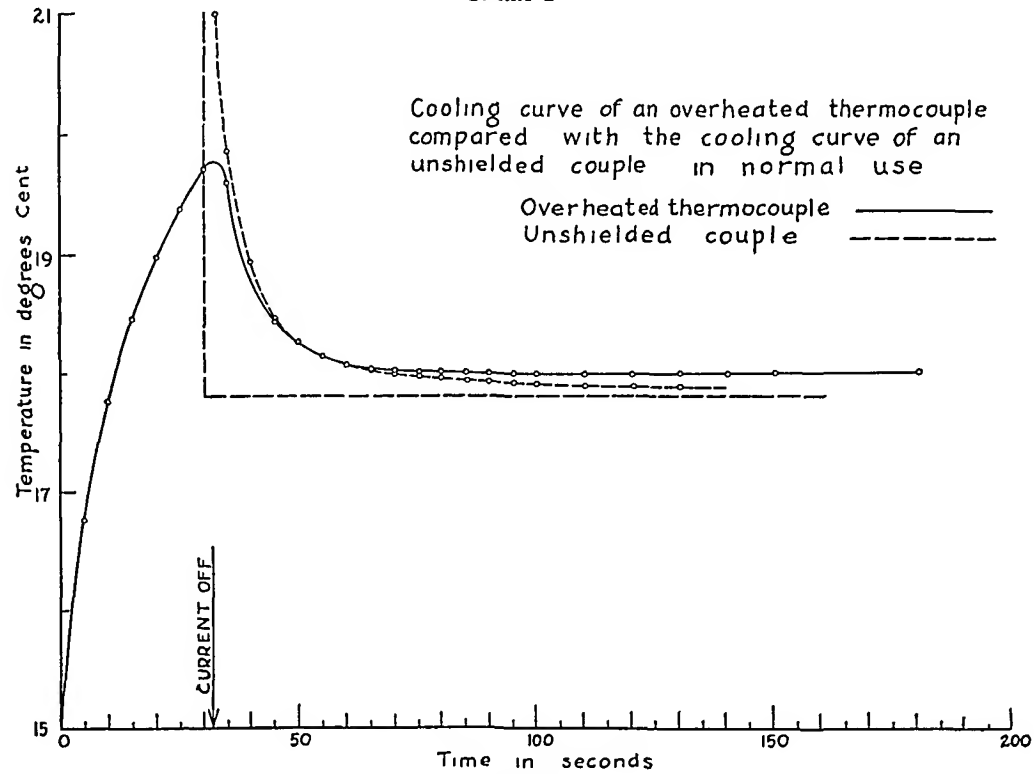
trode with a necessarily reduced range of tip sizes Chart I shows a typical comparison

CHART I



*Stem Conduction*—The study of Bazett and McGlone<sup>11</sup> shows that even with their all metal couples the conduction would vary but little over the range of temperatures herein encountered A constant value would cancel for

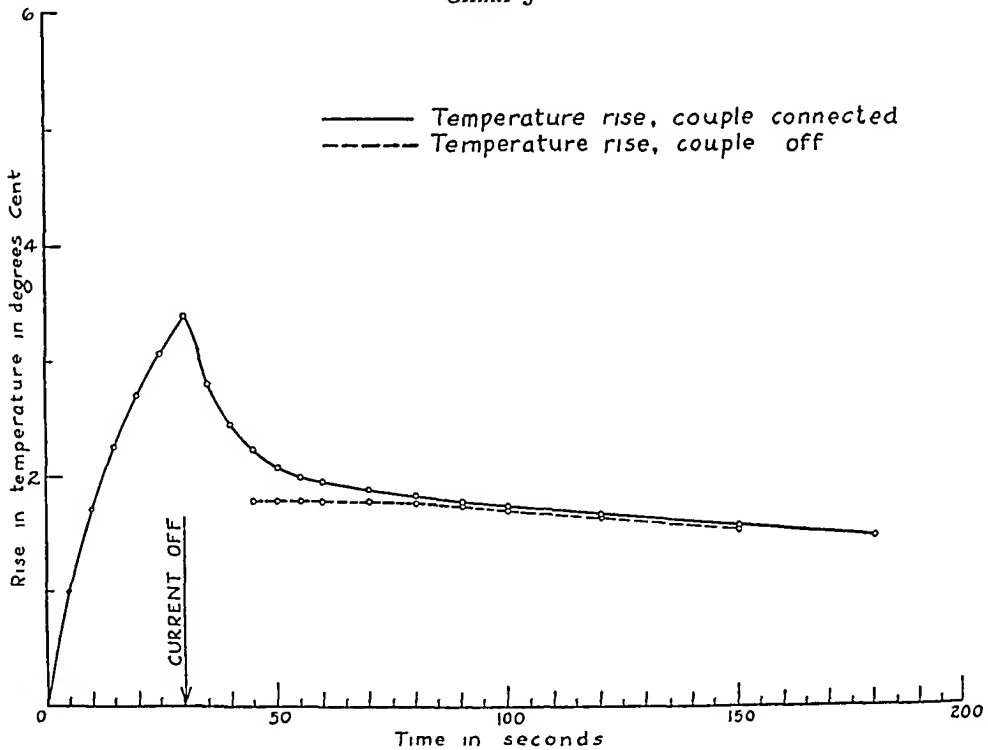
CHART 2



a difference measurement The glass stems used in this work would minimize any error Experiment shows that the size of the tip does not alter the reading as it should if conduction were important

*Electrostatic Pick-Up*—This proved to be the most fertile source of error and by far the hardest to overcome The connection of the couple to the associated measuring apparatus gives it considerable electrostatic capacity Hence it will draw current from the tissue as was explained in the beginning of the article When the current flows through the tissue to the couple, heat is evolved, and the result is a locally heated spot surrounding the tip Chart 2 shows the temperature indicated by a thermocouple whose tip was a pair of No 28 wires fused at the end, which projected 2 Mm from the glass stem

CHART 3



It was located midway between two copper electrodes 6 by 2 cm, 10 cm apart, in beefsteak and was connected to the apparatus during the current flow

Examination of the curve shows that the couple must be overheating The slow cooling rate after the first 50 seconds is entirely inconsistent with the rapid drop in the 25 seconds following the interruption of the current The choke coils shown in Fig 2 offer an extremely great resistance to the passage of high frequency current and should nullify the effects of the capacity of the apparatus connected to them

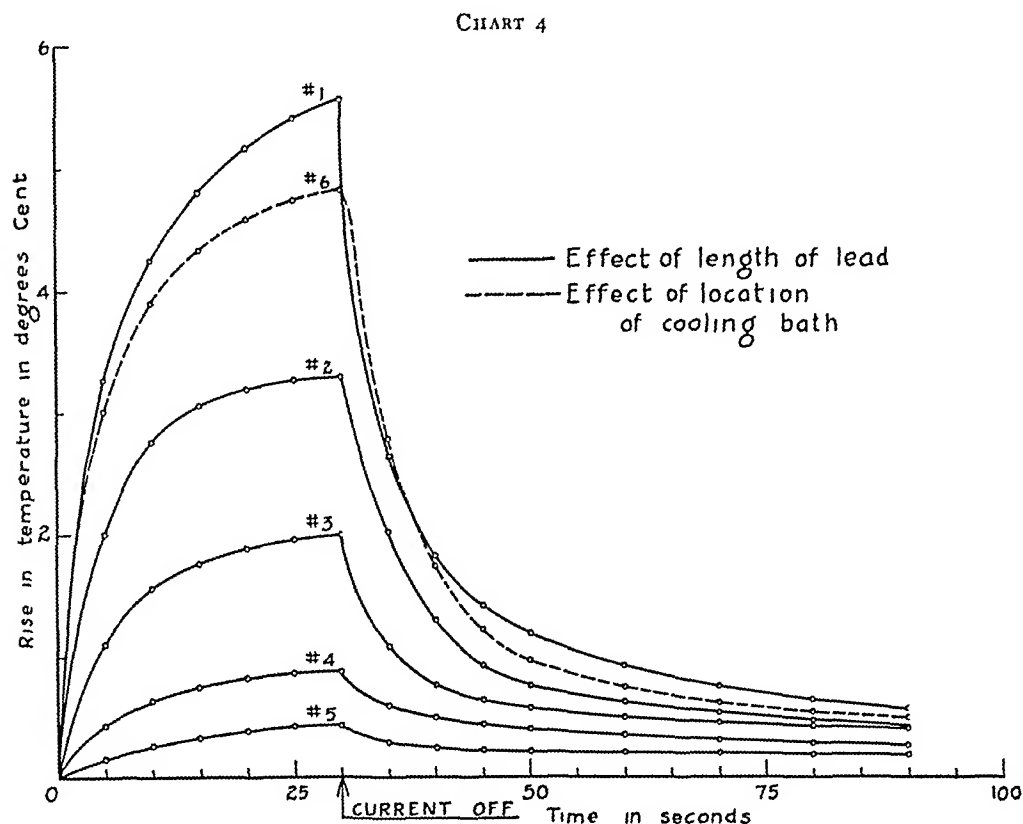
In order to make doubly sure that this was an overheated couple, the tip was heated while in the meat by passing some current from the house mains down one lead and up the other This served to heat only the couple and the meat in direct connection with it The broken curve in Chart 2 is the cooling curve of this overheated couple, with its axes shifted so as to compare with

## HEAT IN ELECTROSURGERY

the cooling of the supposedly overheated couple. The agreement removes all doubt concerning the overheating. These curves have all been repeated under different conditions with the same results, thus eliminating the possibility of chance agreement.

The slow cooling as shown by the tail of the heavy curve in Chart 2 indicates that there ought to be time to connect the couple to the circuit after turning the current off without introducing appreciable error. Chart 3 shows the temperatures indicated by the couple when connected and when disconnected during period of current flow but under otherwise identical conditions.

At first glance it would seem that the chokes ought to prevent the overheating by stopping the pick-up. There are two factors that prevent this



First, there is the capacity of the wires leading up to the chokes and second, there is the capacity of the chokes themselves. The first can be cut by using short leads and the second can be minimized by using low loss chokes. Neither can be entirely eliminated, however.

The effect of length of leads from couple to chokes is shown in Chart 4. The upper curve was obtained with four feet of two strand No. 24 enameled copper wire. The lower solid curves were obtained by successively shortening the leads in steps of one foot until only the usual 14 inch lengths of alloy wire remained. The current in this case was 1.5 amperes between two 3 cm square electrodes 10 cm apart. The couple was not inserted in the field of the current but 10 cm on the other side of the active plate, thus 20 cm in all from the ground electrode. In this location, as was found by experiment, the

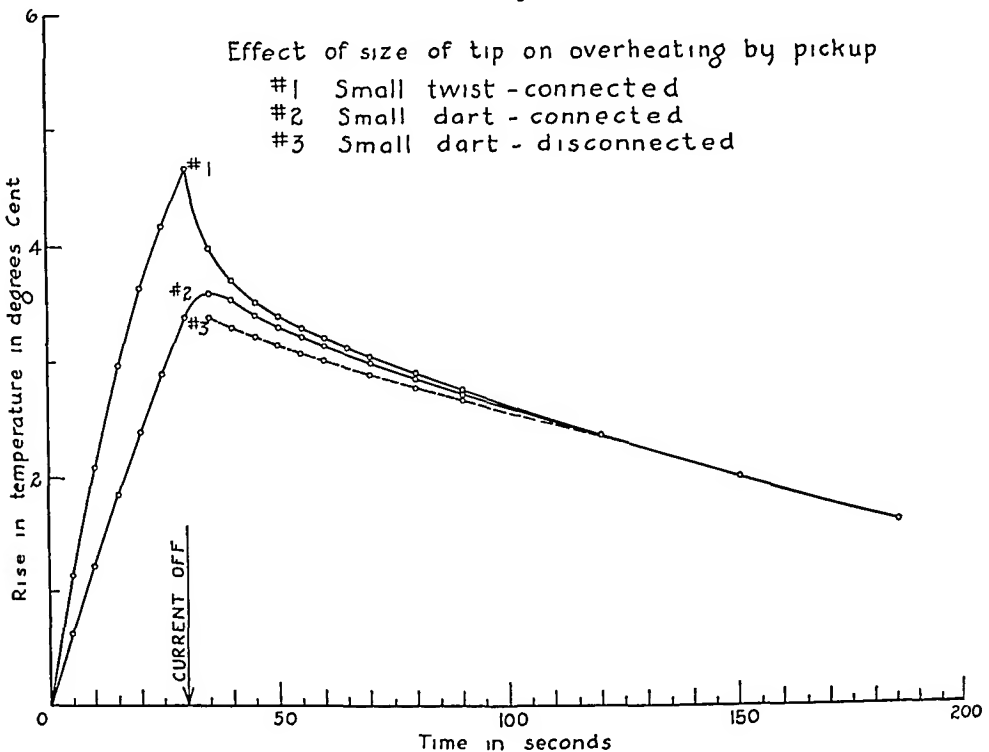
high frequency did not heat the tissue appreciably Any temperature rise was due almost entirely to pick-up

The broken curve No 6 on Chart 4 was obtained under the same conditions as curve No 5 but with the cooling bath moved to the high potential side of the chokes as indicated in the article by Caulk and Harris

Repeating the work as outlined for Chart 4 but with the couple in the current stream gave similar results partly masked by the actual heating of the tissue

The error of the cooling bath is due to the conductivity of the ice water used and to the silver coating of the bottle Using an open flask of water still gave capacity effects thereby indicating the part played by the cool-

CHART 5

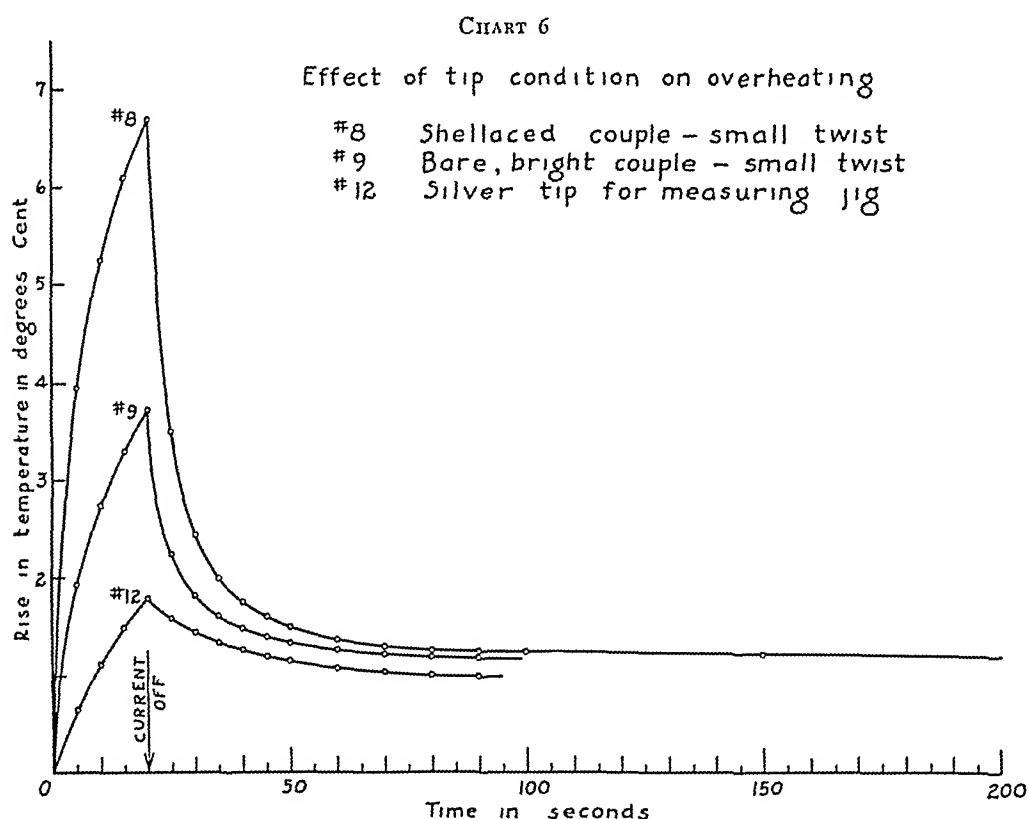


ing water The current fed from the thermocouple to the cooling bath served to overheat it and thus neutralize some of the error from the overheating of the measuring couple This would seem to be a good method of combating the overheating of the measuring couple, but there is no way of being sure that a balance established for one spot of tissue will be maintained for others The addition of the silver blade mentioned previously to the cold junction served to greatly reduce the overheating and the shielding of the cooling bottle completely stopped it

Since it was not possible to eliminate pick-up completely, save by disconnecting the couple, it became necessary to minimize its effects This was accomplished by increasing the surface at the tip of the thermocouple by attaching thereto a small silver dart The increased surface reduced the heating by reducing the density of the picked-up current and by giving more area

for heat dissipation. The effect of the size of the tip on the overheating is shown in Chart 5. The addition of a small flat silver arrow tip of about 3 sq Mm total surface almost neutralizes the error. In any case it is always possible to check against overheating by leaving the couple disconnected during a repetition.

In the work of Caulk and Harris<sup>12</sup> the tips of the couples were coated with shellac. Chart 6 shows the effect of a coating of shellac upon a small tipped couple (couple tip without silver dart). It is quite evident that the addition of the shellac increases the overheating error. The couple leads were increased in order to give some pick-up to demonstrate the difference. This



accounts for the evident overheating of the silver tipped couple (curve No. 12) but is further evidence that the tip decreases the overheating.

Further, in the work of Caulk and Harris the couple tips were smaller than the smallest used for the above work, the leads were about 30 inches long, the cooling bath was on the high potential side of the chokes, and the couples were connected to the chokes while the current was flowing. In view of the demonstrated consequences of each of these changes it seems entirely possible that previous measurements may have been considerably in error. Therefore the following experiments were run to determine the temperatures generated by the high frequency currents. Every precaution was taken to eliminate the above errors.

**TEMPERATURE DETERMINATIONS**—In this work the thermocouples were checked daily against two standard thermometers. The galvanometer circuit was so adjusted as to read 1° C per cm of deflection. Because of the neces-

sary error in measuring distances to cuts, and the error in timing strokes, 5 per cent was considered sufficient accuracy for temperature measurements. A consideration of the possible errors of temperature measurement indicates that they were in all probability within this amount except on the small temperature changes of a few tenths of a degree.

Cutting was done with a Stern-McCarthy loop and the duration of strokes was measured with a metronome. Coagulation currents were applied with the same loop. A previous study indicated that the deep heating effects were the same for spark and vacuum tube currents of equal magnitude as indicated by the thermocouple ammeter used in this work. This allowed the use of vacuum tube current for cutting measurements which was advantageous, because the couple could be left connected\*. Coagulation currents were drawn from a spark generator and effects were measured by the disconnected couple method.

Table I shows how the temperature rises for a series of three second cuts spaced ten seconds apart. The series of cuts served to cut a small hollow in the piece of beef. The distance given is the distance from the bottom of the trough to the thermocouple which was centered under it. The top of the section cut away was an area about 3 cm by 2 cm. Fig. 3C shows how the cutting was done. This was intended to duplicate the temperatures as they would occur in electrical resection of a prostate gland. The dead tissue cools very slowly and the cuts were made more frequently than would actually be the case in an operation. Thus these temperatures ought to be higher than would actually be found. Each line of the table represents work on a different spot in the beef.

TABLE I  
CUTTING UNDER WATER

Number of 3 sec Cuts Spaced in 10 sec	Distance from Bottom of Trough to Couple	Current	Temp Rise C
14	6 Mm	600 Ma	4.1° C
14	7 Mm	600 Ma	4.5° C
10	5 Mm	600 Ma	4.5° C
12	5 Mm	600 Ma	5.3° C
14	3 Mm	600 Ma	5.0° C
15	3 Mm	600 Ma	5.8° C
15	3 Mm	650 Ma	4.9° C (Better cooling)
13	4 Mm	650 Ma	4.7° C
15	4 Mm	600 Ma	5.2° C
14	11 Mm	600 Ma	9° C
7	8 Mm	600 Ma	1.0° C

In Table II the same procedure was followed. In this case, however, a temperature reading was taken as soon as each layer of strokes had been completed. The distance in each case is that from the plane of the strokes to the

\* Because of the single frequency of the vacuum tube generator the current can be more effectively excluded from the measuring circuit than is possible when working with a spark generator.



couple The area of the plane is as stated before However, as the trough deepens the area becomes less, thus decreasing the number of strokes per layer Table II is a typical one taken from several trials all of which agreed well The work here is done under water The temperature given is the total temperature since the start of the whole table

TABLE II  
3 SEC CUTS WITH 650 TO 700 MA SPACED 10 SEC APART  
COUPLE CONNECTED

6 cuts to within 1.8 cm gives a temp of 0.3° C  
3 cuts to within 1.2 cm gives a temp of 0.5° C  
3 cuts to within 1.0 cm gives a temp of 1.1° C  
3 cuts to within .8 cm gives a temp of 3.1° C.  
2 cuts to within .5 cm gives a temp of 4.6° C

Table III is the same as Table II but the spark current was used with the couple disconnected

TABLE III  
SPARK CURRENT 800 MA CUTS SPACED 10 SEC.  
CUTTING ON VEAL

7 cuts of 3 sec to within 2.3 cm gives 0.5° C  
7 cuts of 3 sec to within 1.7 cm gives 1.2° C  
7 cuts of 2½ sec to within 1.1 cm gives 3.2° C  
6 cuts of 3 sec to within .5 cm gives 8.7° C

Table IV gives the results of work on three different beef hearts In this case water at 25° C was flowing on the cut surface The cuts were of 2 sec duration spaced at 20 seconds This was an attempt to duplicate the work resulting in Table IV of the article by Caulk and Harris<sup>1</sup>

TABLE IV

Number of Cuts	Temp Rise° C	Current	Distance to Plane	Remarks
7	0.4° C	550 Ma	1.9 cm	Conduction in 2 min to 1.0 Conduction in 1.1 in 90 sec
8	0.8° C	700 Ma	1.9 cm	
8	0.5° C	500 Ma	1.6 cm	
5	0.6° C.	700 Ma	1.6 cm	
7	0.9° C	500 Ma	1.4 cm	
7	0.7° C	500 Ma	1.4 cm	
7	1.3° C	900 Ma	1.4 cm	
6	0.6° C	700 Ma	1.3 cm	
7	1.0° C	500 Ma	1.0 cm	
6	1.1° C	900 Ma	1.0 cm	
6	1.7° C	700 Ma	0.8 cm	
3	0.8° C	500 Ma	0.7 cm	
5	2.0° C	500 Ma	0.6 cm	
1	2.0° C	900 Ma	0.6 cm	

TABLE IV—*Continued*

1	13° C	500 Ma	0.5 cm	Difference due to spread of plane of three cuts
4	26° C	500 Ma	0.5 cm	
1	35° C	500 Ma	0.3 cm	Two trials identical

A comparison of Table IV with Table IV by Caulk and Harris for similar work shows differences of from 300 to 800 per cent

Temperature determinations were also made on the spark coagulating currents. As would be expected, the heating for a given current is considerably greater because the loop is not moved but left in one place. These following coagulation temperatures were made with the regular No. 12 loop held on edge against the tissue.

Table V shows the typical time of application of coagulating current as observed in an actual prostatic resection.

TABLE V

## COAGULATING CURRENT APPLICATIONS

Time in Seconds	0 to 4	5 to 9	10 to 19	20 to 24	25 to 29	30 to 34	35 to 39	40 to 44	45 to 49	50 to 54
Number of Applications	12	42	34	16	7	1	2	1	0	1

As can be seen, most applications are in the neighborhood of one second. In the above resection all applications longer than one and one-half seconds were made with the loop in motion.

TABLE VI

## COAGULATION CURRENTS

Distance	Time	Temperature	Current
1.9 cm	10 sec	0.5° C	700 Ma
1.7 cm	10 sec	1.6° C	690 Ma
1.6 cm	10 sec	1.6° C	700 Ma
1.6 cm	5 sec	0.35° C three trials	600 Ma
1.3 cm	10 sec	2.0° C	690 Ma
0.9 cm	10 sec	6.5° C	700 Ma
0.95 cm	5 sec	2.9° C	600 Ma
0.8 cm	5 sec	8.7° C	600 Ma
0.7 cm	5 sec	11.6° C	690 Ma

Table VI shows the data from two different days on two different beef hearts. The applications were done under water with running water circulating over the loop. It will be noted that the applications were for either five or ten seconds. The loop was not moved. As a result, it cut into the tissue somewhat and at the end of the application was closer to the couples by about 1 Mm for a 5-sec application and about 2 Mm for a 10-sec one. The distances listed are the initial ones before the application was made. Since

the galvanometer lag introduced considerable error on the rapid temperature changes at distances less than those given, it was found necessary to get information on them in another manner

If a piece of muscle tissue is treated with the coagulating current in the above manner and then cross-sectioned with a scalpel, a peculiar white ring is found surrounding the burned spot in contact with the loop. The sharp definition of the edge of the white ring suggested that perhaps the tissue turned color at a quite definite temperature. By soldering a flat plate of silver to a thermocouple and placing it upon a fresh cut surface of a piece of the muscle, it was easily possible to determine the temperature at which this change took place. The plate was heated by the radio current just as any other electrode would be. Since the temperature at the plate is higher than at any other point, it was only necessary to find the temperature that just whitened the tissue in contact with the plate.

A temperature of 50° C for a minute produced no visible effect. A minute at 62° C gave a very faint whitening and 5 sec at 70° C gave a thin but definite white layer. This places the probable temperature transition point as 65° C  $\pm$  5° C. Doyen<sup>13</sup> gives 65° C.

Table VII shows the extent of this destruction when using a No. 12 loop on edge when under flowing water. The loop was pressed firmly on the tissue but all sparking was not eliminated. The initial temperature of the heat was 20° C. The outer boundary of the white is assumed as 65° C. This means a rise of 45° C at the distance to the edge of the ring. Since the loop is constantly progressing nearer and nearer to the couple, while the current is applied, it is not possible to assign any definite distance to the application.

TABLE VII

Time	Current	a	b	c	d	e	f	Power Set
5 sec	850 Ma	6 Mm	4½	1½	3	7	3	90
4 sec	850 Ma	5 Mm	3½	1½	2½	6	2½	90
3 sec	850 Ma	4½ Mm	3	1½	2½	5	2	90
2 sec	850 Ma	4 Mm	2½	1½	2	4½	1½	90
1 sec	850 Ma	3 Mm	1¾	1¼	1½	3½	1¼	90
5 sec	650 Ma	5 Mm	4	1	3	5	2½	45
4 sec	650 Ma	5 Mm	4	1	3	4½	2¼	45
3 sec	650 Ma	4 Mm	3	1	2	4	2	45
2 sec	650 Ma	3½ Mm	2½	1	1½	3½	1⅓	45
1 sec	650 Ma	2½ Mm	1¾	¾	¾	2½	1	45
5 sec	400 Ma	3 Mm	2	1	1	4	1½	22
4 sec	400 Ma	2½ Mm	1¾	¾	¾	3	1	22
3 sec	400 Ma	2 Mm	1¼	¾	½	3	1	22
2 sec	400 Ma	1¾ Mm	1¼	½	½	2	¾	22
1 sec	400 Ma	1¼ Mm	⅞	⅓	½	1½	½	22

For the significance of a, b, c, d, e, f refer to Figure 4  
a, b—Depth of bottom of white ring and bottom of burned area respectively  
c—Radial thickness of white ring  
d—Depth of wire from surface after current application  
e, f—Horizontal diameter of white ring and burned area respectively

The constant radius of the white ring shows that the fourth power law should be valid for these distances. If temperatures of a locality between the measured values listed and those determined by the white ring are desired, an application of the fourth power law based on the white ring temperatures and also based on the measured values farther out will give the limits within which the temperature at the point in question lies.

The average coagulation current as measured in the actual resection was about 650 Ma. The applications were of the order of one second. A study of the above table shows about what to expect from such an application. In Fig. 4 the shaded area represents the charred tissue and the light shading represents the white ring used as a temperature indicator.

In order to show as closely as possible the difference between this work and the previous study, an attempt was made to duplicate as nearly as possible

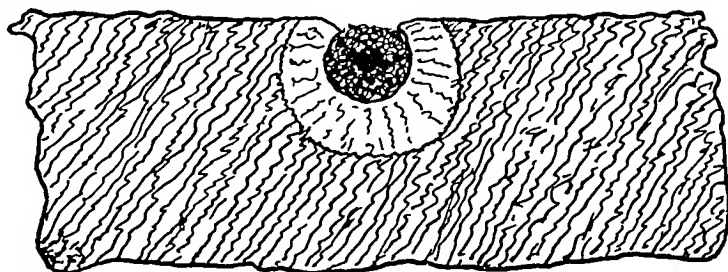


FIG. 4—The shaded area represents the charred tissue, the light shading represents the white ring used as a temperature indicator.

the experiment of Caulk and Harris with a button electrode on a rabbit leg muscle. The measurements were made with the same size of electrode (Table VIII).

TABLE VIII

Distance	Current	Temp Rise	Time	Previous Current	Previous Temp Rise
1 cm	1200 Ma	1 9° C	3	1000 Ma	9 86° C
1 cm	1200 Ma	1 6° C	3	1000 Ma	10 46° C
1 cm	1150 Ma	1 6° C	3	1000 Ma	11 32° C
1 cm	850 Ma	0° C	4		

The cooling by the blood stream in a matter of a few seconds is not large in a muscle. It took some three minutes for the temperature to fall back to normal from the two degree rise indicated above. A further study of Table XI in the report of Caulk and Harris shows that a 6 sec heating does not give double the temperature of the 3 sec heating by a great deal. The difference is larger than can be accounted for by blood cooling. However, from the experience of overheating the couples in order to make the comparisons mentioned previously, it was found that the overheating of the couple is most rapid at the start and soon reaches a point of equilibrium where the picked-up current is just sufficient to maintain the excess temperature. This would account for the difference in the temperature rises in equal intervals of time.

The results of these experiments show, quite plainly, the possibility of

very considerable errors in the use of thermocouples in the presence of high frequency currents and give no evidence of undesirably high temperatures when due precautions are observed

Further, a comparison with the work of Caulk and Harris, as previously indicated from time to time, shows large differences under similar situations. Differences at times are as large as 800 per cent. They conclude as a result of their measurements "In using the various high frequency cutting instruments tissue damage is often produced more deeply than is generally desirable and is often to some extent unavoidable. High current densities applied for more than a second or two may do damage at depths from a few millimeters to over a centimeter." Since the duration of individual cutting strokes during a resection is about three seconds it is doubtful whether most careful application would avoid frequent deep damage with ensuing necrosis and sloughing if the foregoing conclusions are true.

The results of 400 prostatic resections performed with high frequency currents as reported by Alcock<sup>2</sup> do not bear out these conclusions. There are, as pointed out in the clinical findings, indications of sloughing and necrosis following resection, but not of a magnitude consistent with the findings of Caulk and Harris.

The conclusions drawn regarding the destruction caused by the heating effect of high frequency currents are based, of course, on the experimental determination of the thermal death point of cells. The work of Pincus and Fischer<sup>3</sup> indicates that a rise of  $10^{\circ}\text{C}$  maintained for 30 minutes has no apparent effect and that a temperature of  $13^{\circ}\text{C}$  above normal can be withstood for two to three minutes with growth inhibition but without death. Changes in excess of this are almost surely lethal. These measurements were made on isolated cells grown in culture. It seems reasonable to believe that cells in the living organism with normal surroundings could withstand more violent treatment. Thus an estimate of  $11^{\circ}\text{C}$ , irrespective of shortness of duration, as the thermal death point of cells is quite conservative.

The experiments of Caulk and Harris show temperatures well in excess of these values in several instances. Our results indicate a temperature rise of about  $4^{\circ}\text{C}$  at a distance of 0.5 cm following a considerably abnormal sequence of cutting strokes. Temperature changes are correspondingly less at greater distances.

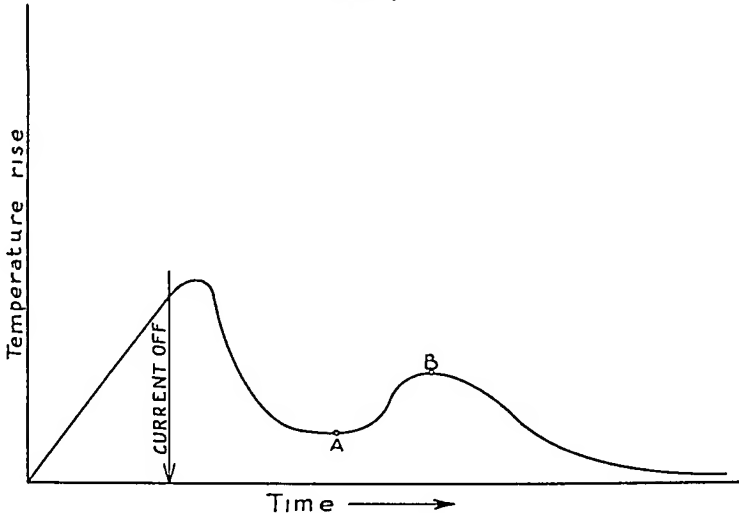
Theoretical consideration of the cooling curve shown by Caulk and Harris in their article gives further evidence of the existence of uncorrected errors in their measurements. When working with small fixed electrodes, such as a small sphere imbedded in the tissue, the error of a moving loop is eliminated. In a part of their work this was done. They give a typical heating and cooling curve which is represented in Chart 7.

The rise in temperature to the first peak is interpreted as the heat of the current. When the current is stopped, the tissue then cools to a temperature as at A and then rises to a peak at B (Chart 7) when the wave of conducted heat reaches the couple from the hotter regions nearer the electrode.

Suppose the heat generated varies inversely as some power greater than the first of the distance from the electrode. If the specific heat stays constant, the temperature will also vary in the same manner. The heat and temperature curve should look as represented in Chart 8 at a given instant.

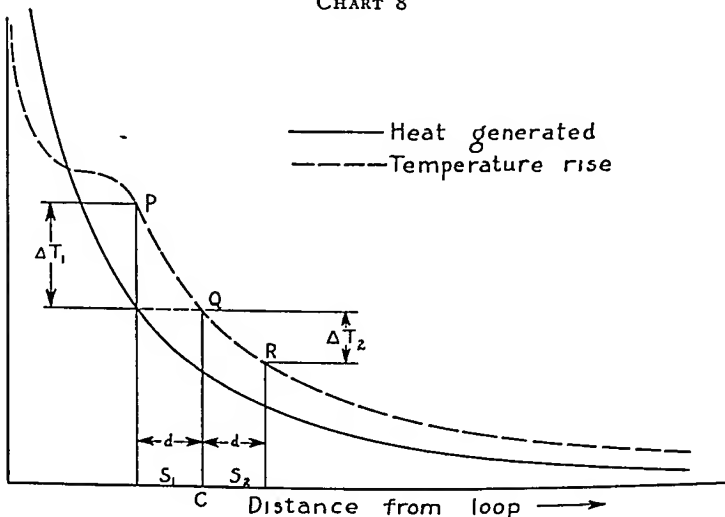
Suppose the couple is located at such a distance that the temperature is

CHART 7



indicated by the point  $Q$ . If we were to examine the temperature a little closer to the electrode, say a distance  $S_1$ , we would find that the temperature was greater by an amount  $T_1$ . If we went an equal distance in the opposite direction from the arrow, we should find that the temperature was lower by an amount  $T_2$ . Further, since the variation of temperature is not a strict

CHART 8

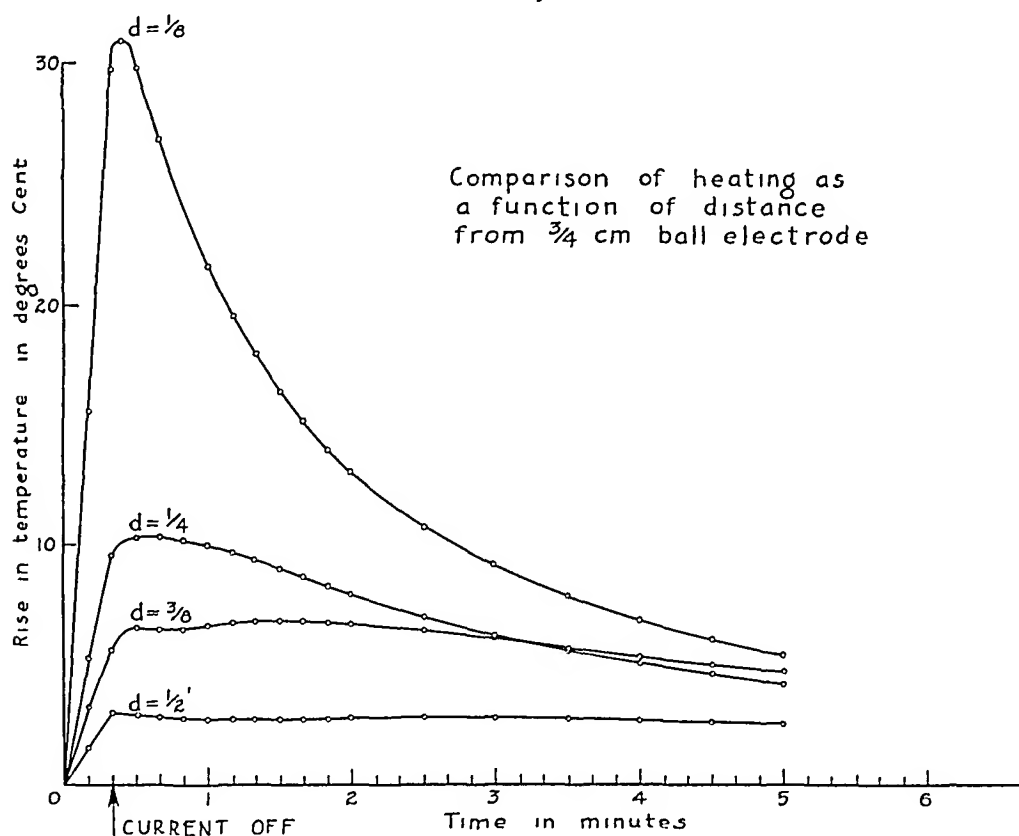


inverse proportion but varies inversely to some power between the second and fourth (Chart 9) with distance, because of the peculiarity of the set up,  $T_1$  will be greater than  $T_2$ . This can readily be seen on the Chart. If  $T_1$  is greater than  $T_2$ , more heat will flow from the hot regions to the couple than from the couple to the cooler regions. Thus when the current is turned off, the temperature should rise or perhaps hold nearly constant, but it could

not fall and then rise again. Once it starts to fall it must continue to do so. To get a curve such as is shown by Caulk and Harris the couple would have to be overheated so that it was warmer than the surrounding tissue.

Chart 9 shows the results of a study of the heating around a ball electrode with a couple whose overheating did not exceed  $0.2^{\circ}\text{C}$ . It will be noted that the temperature rises slightly or holds constant for a time after the current is stopped but does not drop and rise again. This evidence of overheating of the thermocouple in the work of Caulk and Harris points to those errors which tend to overheat the couple as the most likely ones.

CHART 9



The flat portion of the dotted temperature curve of Chart 8 is interesting. It is due to the heat of vaporization of the water content of the cells. It requires about seven to eight times the amount of heat to evaporate the water after reaching the boiling temperature that it does to bring the tissue to boiling. The result is what amounts to a vapor seal protecting the deep tissue from the intense heat at the loop.

#### CONCLUSIONS

The previous considerations lead naturally to these conclusions:

(1) Consideration of sources of error and the results of measurements of generated temperatures indicate errors of from 300 to 800 per cent in the work of Caulk and Harris.

(2) There is little danger from overheating the tissue by use of the cutting currents for any distance greater than 3 Mm. Of course, damage is possible but reasonable care should avoid any trouble.

(3) Heavy coagulation currents when applied from small surfaces will generate dangerous temperatures to a depth of several millimeters. Care to use short applications of current or moving the electrode while applying the current will eliminate the danger.

The author wishes to express his thanks to Professors A. Ellett and G. W. Stewart of the Physics Department for their helpful assistance and suggestions, and to Dr. N. G. Alcock, Genito-Urinary Department, University Hospitals, who suggested the investigation, for willing cooperation and the use of departmental facilities.

## REFERENCES

- <sup>1</sup> Caulk and Harris. *Trans. Am. Assn. Genito-urinary Surgeons*, 26, 135, 1933.
- <sup>2</sup> Alcock. *J. A. M. A.*, 101, 1355, October, 1933.
- <sup>3</sup> Pincus and Fischer. *Jour. Exper. Med.*, 54, 325, 1931.
- <sup>4</sup> Ward and Kelley. *Electrosurgery*. Philadelphia, W. B. Saunders Co., 1932.
- Tousey. *Medical Electricity and Roentgen Rays*. Philadelphia, W. B. Saunders Co., 1916.
- Waddington. *Practical Index to Electro and Photo Therapy*. Detroit, A. M. Margraf Co., 1929.
- Hemingway and Senstrom. *J. A. M. A.*, 98, 1446, April, 1932.
- <sup>5</sup> Mc Clendon. *Am. Jour. Physiol.*, 82, 525, 1927.
- <sup>6</sup> Christie and Loomis. *Jour. Exper. Med.*, 49, 303, February, 1929.
- <sup>7</sup> Morecroft. *Principles of Radio Communication*. New York, John Wiley and Sons, 1927.
- <sup>8</sup> Richardson. *Physiol. Rev.*, 35, 297, 1930.
- <sup>9</sup> Grover. *High Frequency Practice*. Kansas City, Electron Press, 1925.
- <sup>10</sup> Bridgeman. *Thermodynamics of Electrical Phenomena in Metals*, 51, New York, Macmillan Co., 1934.
- <sup>11</sup> Bazett and McGlone. *Am. Jour. Physiol.*, 82, 415, 1927.
- <sup>12</sup> Harris. Personal Communication.
- <sup>13</sup> Doyen. *Arch. d'elec. Med.*, Bordeaux, 17, 1909.



# BRIEF COMMUNICATIONS AND CASE REPORTS

## ACUTE MECHANICAL INTESTINAL OBSTRUCTION CAUSED BY ACUTE APPENDICITIS \*

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NEW YORK

**Case Report**—The patient, age 27, complained of persistent generalized abdominal pain which had started 12 hours previously. The pain, which had shown a tendency to localize in the right lower abdomen, was constant though somewhat colicky. Vomiting occurred once. During the preceding five years the patient had had an occasional similar attack, lasting from one to two hours, which subsided spontaneously.

The physical examination was essentially negative except for marked tenderness in the right and left lower abdomen and by rectum, more intense on the right side, which also showed a moderate degree of rigidity. Temperature 100.2° F. White blood cells 18,000, 94 per cent polymorphonuclears. There was 3+ acetone in the urine. A diagnosis of acute appendicitis was made.

**Operation**—Under general anesthesia, the abdomen was opened through a right lower rectus incision. The appendix was acutely inflamed, covered with fibrin, and was about 10 cm in length. As it was being delivered into the wound, its distal portion was discovered to completely encircle a loop of terminal ileum, which was black in color and markedly edematous. The appendix was bound down at its tip so as to completely obstruct the loop of bowel. There was a considerable amount of free fluid in the pelvis. The tip was freed from its adhesions, which released the constriction of the loop of bowel. The appendix was then removed and the stump inverted. The released loop of bowel meanwhile was kept covered with hot lap pads until sufficient color returned to justify an assumption that gangrene would not occur, after which the cecum and terminal ileum were returned to the peritoneal cavity and the wound was closed without drainage.

Convalescence was smooth except for a slight rise of temperature and some vomiting. A moderate degree of ileus resisted treatment rather stubbornly but was finally controlled satisfactorily. The wound healed by primary union.

Pathologic examination revealed an unusually long appendix (10 cm). Microscopically, it showed a typical acute inflammation that had begun in the mucous membrane and had caused a destruction of the inner coats. There were marked edema of the submucosa, and throughout all coats a widespread infiltration with lymphocytes. Diagnosis—Acute appendicitis.

The case is shown as a surgical curiosity, as I have been unable to find any report of a similar occurrence. One might speculate as to what caused the appendix to occupy its position encircling a loop of small bowel. From the patient's history it would be justifiable to assume that a similar mechanical obstruction had taken place on previous occasions, but had spontaneously relieved itself.

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\* Presented before the New York Surgical Society, January 22, 1936. Submitted for publication April 13, 1936.

DISCUSSION —DR WM F MACFEE (New York) said that although obstruction following operation for acute appendicitis is a fairly common event, obstruction associated with the appendix and occurring before operation is relatively infrequent. Ways have been described, however, in which such obstruction can occur, perhaps the most common being the result of adhesions following some inflammatory process around the appendix. Obstructive bands are not infrequently found in the right lower quadrant in patients not previously operated upon. Another reason for preoperative obstruction would be pressure or angulation of a loop of intestines due to an abscess or tumor in the region of the appendix, and a third cause would be intussusception associated with inflammatory or other changes in the appendix. Still a fourth way in which the appendix can cause obstruction, as was illustrated in Doctor Lewis' case, is that, during some previous attack of appendicitis, the tip of the appendix became adherent to the parietal peritoneum, the mesentery, or, as in the present instance, to the small intestine, with the appendix then acting exactly as an adhesive band, a sling being formed into which a loop of intestine might be forced or engaged. Once this transpires, the ensuing swelling gradually cuts off the circulation of the loop of intestine, and it is also possible that the circulation of the appendix is likewise obstructed by the swollen intestinal loop. In Doctor Lewis' case, the question would arise as to whether the obstruction or the appendicitis was primary. The changes in the appendix may have been due to interference with its circulation brought about by the obstructed, swollen loop of intestine.

DR SEWARD ERDMAN (New York) cited the fact that numerous cases have been reported in which a Meckel's diverticulum has acted as an obstructive band strangulating the intestine. Similarly, adhesions at the tip of an otherwise free appendix would tend to form a band under which the gut could easily slip.

DR KENNETH M LEWIS agreed with Doctor MacFee's explanation of the way in which the obstruction probably occurred, but felt that an acute attack of appendicitis preceded the adherence of the appendix to a loop of bowel, after which the appendix acted just as would a band.

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## ACUTE INTESTINAL OBSTRUCTION FOLLOWING RADIUM TREATMENT OF CERVIX UTERI\*

WM CRAWFORD WHITE, M D

NEW YORK

**Case Report** —A white woman, age 69, had had a supravaginal hysterectomy 35 years ago and later developed an epidermal carcinoma of the cervical stump, Grade 2. In June, 1935, she was given 1,625 mg hr of radium into the cervical canal and 2,925 mg hr against the surface of the cervix. In addition, she was given two courses of high voltage roentgen therapy: 2,400 R units in June, and 3,840 R units in September, four fields, three times around the pelvis. After this she had diarrhea for a short time.

In January, 1936, she was readmitted and was referred to me by Dr T C Peightal. For one month, she had had occasional lower abdominal pain. Twenty-four hours before admission she was seized with lower abdominal pains of great severity, extending down

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\* Read before the New York Surgical Society, March 25, 1936. Submitted for publication June 8, 1936.

the front of both legs Shortly afterward she began to vomit jejunal contents, this continued off and on at intervals

Roentgenologic examination disclosed distention of the small intestine with fluid levels in the various dilated loops and a shifting fluid level in the stomach There was no distention of the large bowel

At operation, it was discovered that the ileum, about one foot from the ileocecal valve, was adherent to the serosa of the uterine stump When brought into the wound, the ileum was found to have a marked cicatricial contracture with induration The lumen was opened on its antimesenteric border and ulcerated mucous membrane could be seen in an area measuring 1x1.5 cm It had a greenish yellow color The lumen was completely obstructed

Microscopic examination showed no evidence of malignancy, but well defined radiation necrosis with ulcer of the ileum

Resection of the ileum was performed with lateral anastomosis The patient did well for awhile and then began to show renewed signs of ileus She developed a mesenteric thrombosis extending from the site of the anastomosis 200 cm up the ileum There were no twisting of the gut and no leakage The dead bowel was excised and the viable ends brought into the wound She died three days later

It is our belief that this loop of intestine became adherent to the posterior surface of the uterine stump shortly after the supravaginal hysterectomy 35 years ago Then the radium treatment to the cervical cancer caused a radium burn, with secondary ulceration, contracture and obstruction She had had premonitory symptoms for some months until, finally, complete obstruction developed

DISCUSSION—This case is cited as revealing a comparatively new cause for intestinal stricture and obstruction With the increasing use of radium, more such cases will arise We have already had one other instance of chronic obstruction of the sigmoid due to radium treatment of the uterus

Pemberton<sup>1</sup> called this complication to our attention in 1932, and other reports are beginning to appear In this case, with carcinoma of the stump of the cervix, we were faced with a definite risk It is agreed that surgery alone in this type of case is not as efficient as radium It is also agreed that this type of case is apt to have peritoneal adhesions from the previous operation Some have proposed an abdominal examination by celiotomy beforehand, but this seems radical, and moreover will not prevent the rapid reformation of adhesions At present, it must be admitted that this complication, which may appear months after treatment, is one of the necessary hazards of the treatment It is well to bear the possibility in mind, however, and operate, instead of being content with a diagnosis of obstruction with recurrence, and letting the patient die needlessly

#### REFERENCE

- <sup>1</sup> Pemberton, Frank A. *Am Jour Obst and Gynec*, 24, 552

DISCUSSION—DR JAMES A. CORSCADEN (New York) emphasized that Doctor White's report merits attention of the general surgeon as much as that of the gynecologist, because cases of this kind will continue to be seen, even more frequently than at present The patient may be given up as hopeless because of a diagnosis of the condition as intestinal obstruction due to

carcinomatous extension, despite the fact that following the heavy dosage given they are likely to be free of carcinoma, and thus be denied the institution of remedial surgery.

About 4 per cent of the cases at the Sloane Hospital for Women, since 1933, have had some severe intestinal complication requiring surgical relief, and in reviewing the types of lesions, it appears that the difficulty seems to be the result of excessive roentgen therapy. The lesion is diffuse, involving all of the intestines, both small and large, below the umbilicus, and may consist of simple congestion, ulceration or perforation.

Experimental work has demonstrated conclusively that the intestinal mucosa is relatively very susceptible to radiation, in the specimens at the Sloane Hospital, the cloudiness and dissolution of the mucous elements and the normal appearance of the muscle have been very striking. In other cases, where radium is thought to be the more at fault, the lesion is more likely to be localized in the anterior wall of the sigmoid or in the wall of an adherent loop of small bowel. The more common—and probably the more difficult case to handle—is that in which both radium and roentgen therapy have been applied. There are two types. One exemplified by the patient described by Doctor White, in whom there seems to have been a loop of intestine either adherent before the time of the radium application or possibly held there during the time of its application, and the other in the rectosigmoid or sigmoid itself. In these cases, the uterus is often separated by three or four centimeters from the anterior wall of the sigmoid. A maximum dose of radium alone would not be sufficient to cause the necrosis and cicatricial contraction, it is the added effect of roentgen therapy that completes the damage.

The time of onset is anywhere from immediately after treatment to 22 months. Jones has reported cases seven years after the application of radium. The symptoms range from mild diarrhea to acute intestinal obstruction. The method of handling the condition is individual and varied. Only one generalization might be made. If the intestinal operation is undertaken within a year or so after the application of radium or roentgen therapy, it is wise to interfere with the injured portion of the intestine as little as possible. In the few cases where attempts have been made to remove it, there has been failure of healing of the intestine with ulceration and fecal fistula. Where there has been a colostomy and later side-to-side anastomosis, some of the patients have done well. From the practical standpoint, one is dealing with tissue almost devoid of circulation due to the injury to the intima from the rays.

DR BEVERLY C SMITH (New York) concurred in the prediction that the general surgeon would probably see an increasing number of cases with intra-abdominal pathology of the intensive radiation of epithelioma of the cervix as the result of the large doses of roentgen therapy and radium, now being given. In this connection he reported the following case.

**Case Report**—Unit No 323288, a woman, age 56, was admitted to the Sloane Hospital on December 18, 1931. Following a biopsy which showed squamous cell epithelioma of the cervix, she was given the following radiation: 150 mg in the uterine cavity, filtered by 0.5 mg of lead, for 36 hours, and 25 mg in each vaginal fornix, in steel needles with 2 mg of lead filter and separated from the mucous membrane by 0.5 cm of gauze, for the same period, totaling 5,400 mg hours of treatment. The epithelioma on the posterior lip of the cervix extended to the external os, did not involve the

cervical canal and showed ulceration 2.5 cm in diameter, extending to the posterior vaginal reflection. The broad ligaments were apparently not involved. From February 24, 1932, to September 12 (seven months) she received a total of 3,000 R 100 kVp treatments divided over (1) anterior lower abdominal, and (2) posterior gluteal fields, each 20x20 cm. She received, in all, 50 100 kVp treatments, divided into three series. The epithelioma disappeared under treatment and her general health was good. On September 19, 1933, 22 months after radiation and 11 months after the 100 kVp treatments had ceased, she was admitted to the Presbyterian Hospital, with symptoms of intestinal obstruction which were partially relieved by treatment, but recurred and on October 2, 1933, she was explored for an intestinal obstruction. A gangrenous area of terminal ileum 2x2 cm, 12 cm proximal to the ileocecal valve, was found adherent to the cecum, and an area of lower sigmoid presented for 12 to 15 cm a white, flaccid appearance typical of complete gangrene. The edges were sharply delimited. This had perforated, and there was a lower pelvic peritonitis. The gangrenous sigmoid and ileum were brought up into the wound and excised, leaving the patient with two fistulae. Her condition was such that an extensive resection was not thought advisable. Following the operation, she sloughed out more sigmoid and ileum so that the two fistulae openings emptied into a localized abscess in the left iliac fossa, which was lined with fine pale granulations showing little evidence of repair. She died on December 13, 1933, of inanition and sepsis in spite of all supportive treatment. The autopsy revealed no further extension of gangrene of the gut other than that seen at operation, a dilated iliac fossa, peritoneal abscess, fibrosis of the submucosa of the bladder vessels with partial obliteration of their lumen, fibrosis of all tissues of the pelvic wall, and thrombosis of the left hypogastric vein. There was no evidence microscopically of residual epithelioma in the cervix, vaginal wall, or the regional lymph nodes. The striking features of this case were the onset of gangrene of the gut 22 months after radium treatment and 11 months after roentgen ray treatment, and the complete necrosis of portions of the sigmoid and ileum with perforation, peritonitis and fistulae formation which resulted in death.

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## INTESTINAL OBSTRUCTION CAUSED BY A DRIED PEACH

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INTESTINAL obstruction due to food is not common. In a series of 5,363 autopsies from October 15, 1914, to November 19, 1935, at the University of Kansas Hospitals, no other case of intestinal obstruction due to food is recorded. The following case is an unusual instance of such an occurrence.

**Case Report**—E. P., a colored female, age 76, became suddenly ill February 17, 1935, with severe abdominal pain. This was followed by nausea and vomiting. A diagnosis of intestinal obstruction was made. The patient died in her home the following day after an illness of 24 hours. A coroner's inquest was held.

**Autopsy Report**—The body was that of a colored female, age about 76, and weighing approximately 250 pounds. The jaws were edentulous with marked absorption of

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the alveolar ridges. The abdomen was obese and slightly distended. With the exception of a small umbilical hernia and some edema of the lower extremities, the remainder of the external examination was negative.

Inspection of the abdominal cavity showed the umbilical hernia to be filled with omental fat. The stomach and small intestines were distended with gas and fluid. This was most marked in the terminal ileum while the colon was reduced in size and empty. The serosa of the ileum was injected, and in a few places granular, but no other signs of an acute peritonitis were present. There was only a slight increase in free peritoneal fluid. There was no volvulus, intussusception, adhesive bands or "kinks" to account for the obstructed appearance of the gut.

The cause of the obstruction could be palpated in the ileum at the ileocecal valve.

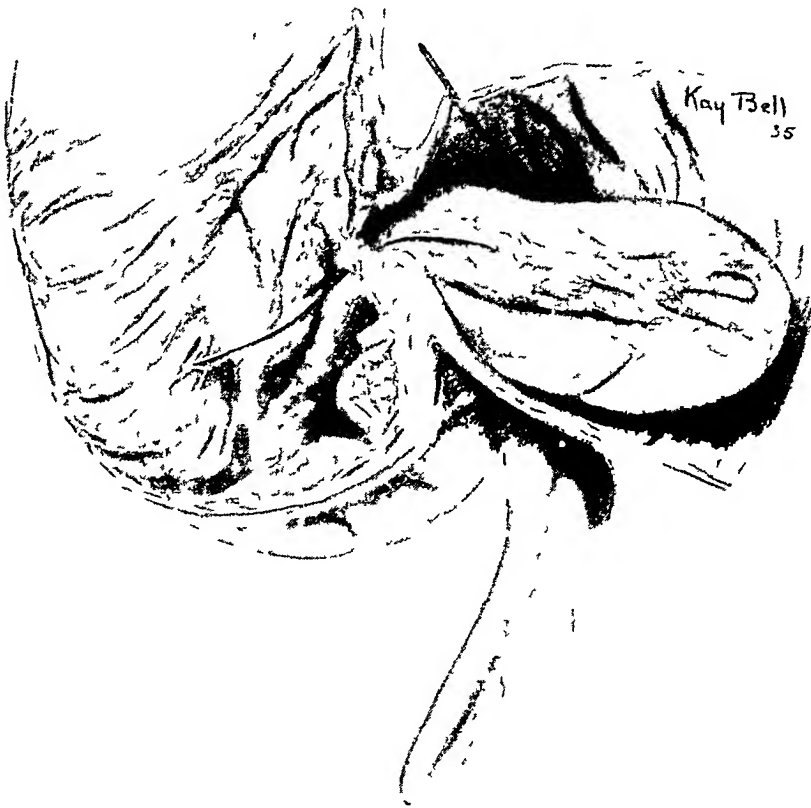


FIG 1.—Drawing showing swollen dried peach lodged in the terminal ileum at the ileocecal valve.

On opening the terminal ileum and cutting toward the valve, a light yellow ovoid body was found in the lumen of the gut (Fig 1). This was lodged within the ileocecal opening and the folds of mucosa extending into the cecum were swollen and edematous. The circumference of the valve appeared to be normal and no scarring or evidence of ulceration could be noted.

When removed and examined the foreign body had the appearance of a dried peach which has been soaked in water prior to cooking. The ragged inner surface next to the seed and a small blemish on the skin side could readily be recognized.

The other findings at autopsy were of a chronic nature, namely, a chronic myocarditis, cholecystitis and cholelithiasis with a stone in the cystic duct, and arteriosclerotic nephritis.

Further history relative to the deceased's diet was obtained. The family stated that two days prior to her death, or about 24 hours before the onset

of her symptoms, she had eaten a raw dried peach while her daughter was washing and preparing some for cooking

From the history and findings at autopsy it is apparent that the patient's death was due to intestinal obstruction caused by an indigested dried peach. Having no teeth the patient evidently swallowed the peach with little or no mastication.

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## VAGINAL ANUS \*

TWELVE YEAR POSTOPERATIVE FOLLOW UP

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NEW YORK

**Case Report**—The patient, a female, at the age of eight, was admitted to Roosevelt Hospital, April 16, 1924, complaining of fecal incontinence with occasional nausea and vomiting. She had been incontinent since infancy. Her past history was otherwise irrelevant.

Physical examination revealed that there was no anal opening at the normal site, in its place, there was a deep depression of the perineal skin and underlying soft parts. The vulval cleft, clitoris, labia majora, urethral and vaginal openings were normal. There was, however, an opening of the rectum, separated from that of the vagina by a corrugated septum, apparently formed by the joined posterior ends of the labia majora. The hymen was intact. This misplaced opening of the rectum admitted the tip of the little finger. It was more of a transverse slit than a rounded, puckered, anal opening.

**Operation**—The incision was begun in the introitus of the vagina, carried well around and downward to either side of the misplaced anus and extending further down in the midline of the perineum to the region of the tip of the coccyx. The anus was dissected, with great care, from its position in the vagina, precaution being taken to preserve the blood supply of the lower rectum, which had to be mobilized. The borders of the levator ani muscles were definitely identified and the anus and terminal three inches of the rectum were brought downward and backward and the anus sutured with interrupted fine silk to the skin. There seemed to be, in the region toward the coccyx, a rounded muscle superficial to the levator ani muscles which gave one the impression of a poorly developed sphincter ani. This rudimentary sphincter was sutured around the terminal one-half inch of the rectum with interrupted sutures of fine chromic catgut. The levators were also sutured together around the lower portion of the terminal rectum in order to be sure that the rectum would obtain a sphincteric action from the levators in case the rudimentary sphincter ani muscle did not function properly. The perineum was carefully built up over the newly placed rectum and the vagina sutured. A small rubber tissue drain was placed in the lower portion of the perineum just anterior to the rectum. There was practically no tension exerted on the mobilized rectum as it was brought down and sutured in its new position. In fact, there seemed to be a redundancy of the rectum, so that we did not anticipate that it would retract and pull upward as healing took place.

**Postoperative Course**—An uneventful recovery ensued. Fecal incontinence persisted up to the twenty-fifth day at which time the patient was allowed out of bed. From then on, she was able to use the commode or go to the toilet. She had perfect control over defecation four months after operation.

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In the summer of 1935 she became pregnant, and was advised not to let the pregnancy go to full term, unless it should be delivered by cesarean section. She was aborted before the third month of pregnancy.

COMMENT—Vaginal anus is one of the most common of the congenital defects of the anus and rectum, occurring in about 40 per cent of the group of defects where the rectum may open into the urethra, bladder, uterus or vagina.

Collins, at the Rotunda Hospital in Edinburgh, found only one case of vaginal anus in 16,000 obstetric cases. Winckel found only a single case of this condition in 12,000 babies at the Dresden Hospital. Morgagni records the case of a woman with an abnormal opening of the rectum into the vagina who lived to be 100 years of age, and who never knew of her congenital defect. Paschal reported that a woman with a vaginal anus gave birth to three children. She did not know of her defect, nor did her husband, nor did the accoucheur who delivered her on the three occasions.

The symptoms are variable, depending upon the size of the anal opening in the vagina. If there is no sphincteric muscle surrounding the misplaced anus, incontinence is the chief symptom. If the opening is small and slit-like obstructive symptoms are soon manifest.

The ideal time for operative intervention is from the eighth to the twelfth year, when the parts have become fairly well developed, and before menstruation takes place. The basic principles of the operation are first, an easy and painless outlet for the feces, second, good sphincteric control, and, third, a position of the outlet well back in the midline of the perineum. A good result is usually assured within six months to one year, especially if the sphincteric muscle is found already around the terminal rectum, or when it is found in the region of the tip of the coccyx. If no definite sphincteric fibers are identified and the levator fibers are utilized, one year to one year and one-half may elapse before any normally controlled movements occur. The operative mortality is low.

DISCUSSION—DR OTTO C. PICKHARDT (New York) recalled a similar case shown by him before the New York Surgical Society several years ago, in which he also had obtained good results. The condition was very rare, occurring about once in 10,000 births. When first seen, the natural impulse is to do something. However, conservatism should prevail, for early operation—whether palliative or extensive—is likely to prove fatal. The main reason for operating later is the lack of knowledge of the exact extent or size of the rectum, or of how far down it will come, until between the ages of eight and twelve, which as stated by Doctor Cave is the best time for the operation to be performed. The procedure to be undertaken will depend somewhat upon whether the anal opening is in the vagina. The farther back it is, the more extensive must the operation be. In Doctor Pickhardt's case, the opening was well posterior and so, in order to mobilize the rectum completely, it was necessary to remove the coccyx and a small portion of the sacrum. Following this, the rectum was freed from the vaginal wall, then pulled downward and out through the sphincter, which had been opened, and a generous cuff of mucosa was left. Postoperative care is most important.



## HEADACHE AS A SYMPTOM OF CERVICAL RIB

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MUCH has been written on the subject of cervical rib and its associated neurologic and vascular symptomatology. Nowhere in the literature, however, is there mention of headache as a symptom of this anomaly. Two years ago one of us (M A L) in association with Dr Walter C S Koebig of Los Angeles studied a case (which will be published shortly) of cervical rib in which headache was the most prominent symptom. The case was that of a woman of 47, who for 12 years had had a left parietal and occipital headache. A most careful examination was made and all possible foci of infection were eliminated. The eyes in particular were examined and errors of refraction corrected. The headache persisted. Doctor Koebig then suggested that a left cervical rib, which was known to be present, might be the cause of the headache. As there was nothing else that had any evident causal relation with the headache, it was decided to remove the cervical rib. This was done and the headache promptly disappeared and has not returned since. Incidentally this patient has a daughter of nine who has bilateral cervical ribs but no headaches.

**Case Report**—The patient, a girl, age 11, was admitted to the Hospital for Joint Diseases November 11, 1935. Her chief complaint was intense right-sided headache, mainly in the frontal and parietal regions. She had been suffering from this headache for two years. The pain was intermittent but severe. It came on rather regularly after rising in the morning and particularly after physical exertion, and was increasing in intensity, so that in recent months it interfered with her school work. On many occasions while in school the headache became so severe that she had to go home. Usually rest in bed for several hours afforded her relief. In addition, for the past five years, she has had attacks of pain in the right supraclavicular region which had recently become more frequent and more severe. During the month preceding her admission she had begun to experience pain and weakness in the right wrist.

The family history was irrelevant. Past history: measles, mumps and suppurative otitis media resulting in bilateral mastoiditis requiring mastoidectomy.

The physical examination showed a well developed girl with head tilted to the left. At the base of the neck on the right side there was a mass, hard in consistency, about two inches in the horizontal and one and one-half inches in the anteroposterior diameter. It apparently arose from one of the lower cervical vertebrae and extended laterally towards the clavicle. There was a marked pulsation in front of the mass and an easily audible bruit. In the left side of the neck there was no visible or palpable mass. The blood pressure in the right arm was 110/45, in the left arm 90/40. The radial pulses were equal in frequency and normal in rhythm. The eyes were normal except for a slight internal strabismus on the right side and a slight horizontal nystagmus. The rest of the physical examination was negative.

The anteroposterior roentgenogram of the neck (Fig 1) showed a small cervical rib on the left side and a very large one on the right side. The right cervical rib was segmented, and extended from the body of the seventh cervical vertebra to the first rib, it appeared to be about two and one-half inches long.

The right cervical rib not only caused a conspicuous deformity of the neck, but seemed the most likely cause of the patient's suffering. Consequently, excision of the anomalous rib was advised and undertaken November 15, 1935. Considerable thought was given to the method of approach. As the rib seemed very superficial posteriorly, it appeared wise to use the posterior approach, hoping to completely avoid contacting the blood vessels. It was appreciated that the posterior incision would probably preclude adequate exposure and release of the lower attachment of the scaleni muscles, but on the other hand, it was anticipated that removal of the cervical rib alone would relieve



FIG 1—Anteroposterior view of cervicodorsal region. (A) Arrows point to a segmented cervical rib which extended from the body of the seventh cervical vertebra to the first rib. The apparent gap between the proximal and distal segments was found at operation to be cartilaginous, without any break in the continuity of the rib.

the symptoms. Accordingly a vertical incision was made along the anterior border of the trapezius muscle. At the base of the neck the incision was curved forward. By slow dissection the middle of the rib was exposed without cutting any major nerves and without encountering any anomalous blood vessels. The tissues in front of the rib were gradually elevated, exposing the whole of the rib which extended from the body of the seventh cervical vertebra to the first rib. The rib was cut through the middle, an apparently cartilaginous area. The proximal segment was removed first and then the distal portion was excised. As the soft tissues in front of and below the rib had been lifted en masse, there was little danger of puncturing the lung. The wound was closed without drainage and healed by primary union. The postoperative course was quite uneventful. The headache, pain in the neck and in the right wrist completely disappeared.

**DISCUSSION**—Although strabismus and nystagmus may at times initiate or be responsible for headache, they manifestly had no such effect in the case cited, as the headache persisted after the strabismus was controlled by

corrective glasses, but disappeared promptly after removal of the anomalous rib

The interesting question that naturally arises in a consideration of this case is, what is the pathogenesis of the headache? By the process of post hoc propter hoc reasoning the cervical rib caused the headache, but we are uncertain as to the exact mechanism. In the absence of any other explanation it may be assumed that the cervical rib, by its proximity, caused pressure upon the cervical sympathetic and the vagus nerves. This friction by reflex irritation caused the headache. This terminology is vague and unfortunately necessarily so because of our inadequate understanding of the function of the sympathetic system. Mayer<sup>25b</sup> in his paper on "The Neurologic Conception of Headache" stated "The physical pain which we style headache arises from the sympathetic, trigeminal, occipital or upper cervical nerves, due either directly to disease of these nerves or to edema, increased pressure or circulatory changes which affect them. The brain itself has no nerves and feels no physical pain, so that an inevitable conclusion must be that pain itself is a purely mental state." In view of the fact that the dura mater within the cranium is supplied mostly by the second and third divisions of the trigeminal nerve and by *branches of the vagus*, irritation through direct pressure on any of their branches or stimuli referred through these nerves, which are distributed through the head and neck, may produce a pain within the cranium, that is, headache. Certainly a mass such as the anomalous rib removed from the case here recorded was big enough and occupied sufficient space in the neck to cause pressure upon, and irritation of, the vagus and the cervical sympathetics to give rise to reflex symptoms within the cranium.

SUMMARY—(1) A case is reported in whom the major symptom of a cervical rib was headache.

(2) The headache, which had been present for several years and had become not only very severe but disabling, has been completely and apparently permanently relieved by extirpation of a cervical rib.

(3) The patient had bilateral cervical ribs. The one on the left side was very small and, as is found in so many cases, gave no clinical manifestations other than a positive roentgenogram. The cervical rib on the right side was very large and was characterized locally by a mass and pain and by ipsilateral severe and increasing headache.

(4) The increasing headache may be explained on the basis that the cervical rib was growing and by its increasing size caused greater nerve irritation.

(5) The cervical rib occupying a large part of the area at the base of the neck inevitably pressed upon the vagus nerve, branches of which supply the cranial dura mater, thus establishing the potential physical basis of the headache.

(6) Mention is made of another case of cervical rib causing headache.

observed by one of the authors. In this case, also, the headache was relieved by excision of the rib.

(7) From our experience it is logical to urge the removal of any cervical rib that is growing, as it is likely to cause symptoms resulting from irritation and pressure.

(8) The posterior approach to the cervical rib seems to us preferable to the anterior, especially when there is no evidence of pressure upon the subclavian vessels, since it is easier in this way to avoid injury to the major vascular and nervous structures in the neck.

## REFERENCES

- <sup>1</sup> Adson, A. W., and Coffey, J. R. Cervical Rib. *ANNALS OF SURGERY*, 85, 839-857, June, 1927.
- <sup>2</sup> Brush, C. E., Jr. Notes on Cervical Rib. *Johns Hopkins Bull.*, 12, 114-117, Baltimore, 1901.
- <sup>3</sup> Church, A. The Neurology of Cervical Rib, *J. A. M. A.*, 73, 1-4, 1917.
- <sup>4</sup> Collins, C. V. Cervical Rib. *Am. Jour. Surg.*, 14, 449-451.
- <sup>5</sup> Colonna, P. C. Cervical Rib with Report of Two Cases. *Am. Jour. Med. Sci.*, 163, 80-87, 1922.
- <sup>6</sup> De la Punte. Cervical Rib. *Semana Med.*, 1, 326-328, 1934.
- <sup>7</sup> Dunlop. Cervical Rib. *Lancet*, 2, 500, 1928.
- <sup>8</sup> Evans, E. S. Cervical Rib. *J. A. M. A.*, 58, 4, 1912.
- <sup>9</sup> Goodhart, S. P. Cervical Rib and Its Relation to Neuropathies. *Jour. Nerv. and Ment. Dis.*, 35, 586, 1908.
- <sup>10</sup> Henderson, M. S. Cervical Ribs. *Am. Jour. Ortho. Surg.*, 11, 408-430, 1914.
- <sup>11</sup> Howell, C. M. H. A Consideration of Some Symptoms Which May Be Produced by Seventh Cervical Ribs. *Lancet*, 1, 1702-1707, 1907.
- <sup>12</sup> Honey, J. A. Cervical Ribs with Presentation of Cases and a Bibliography. *Surg., Gynec. and Obstet.*, 30, 481-493, 1920.
- <sup>13</sup> Kammerer, F. Cervical Ribs. *ANNALS OF SURGERY*, 34, 637-648, 1901.
- <sup>14</sup> Keen, W. W. Cervical Ribs. *Am. Jour. Med. Sci.*, 133, 173-218, 1907.
- <sup>15</sup> Kanderlen, E. Zwei Falle von Halsrippen. *Deutsche med. Wchnschr.*, 26, Ver. Beil., 61, 1900.
- <sup>16</sup> Menocal, R. Uno caso del cortilla cervical. *Semana Med.*, 10, 269, 1903.
- <sup>17</sup> Miller, J. L. Some Observations on the Symptomatology and Diagnosis of Cervical Rib. *Am. Jour. Med. Sci.*, 142, 811-815, 1911.
- <sup>18</sup> Murphy, J. B. The Clinical Significance of Cervical Rib. *Surg., Gynec. and Obstet.*, 3, 514-520, 1906.
- <sup>19</sup> Plummer, W. W. Cervical Ribs. *Am. Jour. Ortho. Surg.*, 14, 146-149, 1916.
- <sup>20</sup> Pool, E. H. Cervical Rib. *ANNALS OF SURGERY*, 73, 787-789, 1921.
- <sup>21</sup> Reilly, T. F. Headache, Its Causes and Treatment. P. Blakiston's Son and Co., Philadelphia, Pa., 1926.
- <sup>22</sup> Roberts, J. B. The Surgical Importance of Cervical Ribs to the General Practitioner. *J. A. M. A.*, 51, 1126-1130, 1908.
- <sup>23</sup> Seiffer. Ein Madchen Mit Doppelseitiger Halsrippe. *Ber. klin. Wchnschr.*, 41, 818, 1904.
- <sup>24</sup> Spellissy, J. M. Cervical Rib. *ANNALS OF SURGERY*, 45, 638, 1907.
- <sup>25</sup> Symposium on Headache, Reprint from *Penn. Med. Jour.*, December, 1907.
  - (a) Samuel D. Risley
  - (b) Edward E. Mayer
  - (c) J. C. Wilson
  - (d) B. Alex. Randall

- <sup>26</sup> Taylor, A S    Cervical Rib    ANNALS OF SURGERY, 93, 778, 1921  
<sup>27</sup> Thorburn, W    The Symptoms Due to Cervical Rib    Med Chron (Manch ), 8, 165-191, 1907  
<sup>28</sup> Webster, J C    Cervical Rib    Jour Mich Med Soc, 30, 615, 1931  
<sup>29</sup> Wolff, E M    Ueber Halsrippen, Berlin, 1918 (Thesis)

## A SIMPLE METHOD OF MEASURING SKIN FOR SKIN FLAPS

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MILWAUKEE, WIS

I WISH to call attention to a simple method of measuring skin for skin flaps. The method has been found to be very satisfactory and eliminates the time consuming procedures usually employed to determine the availability of



FIG 1—Before the skin graft (interoposterior view) Note the scar tissue at the bridge of the nose



FIG 2—Before the skin graft (lateral view)

sufficient skin as well as the actual amounts necessary to fill in a given defect. Plaster or gelatin models, and caliper measurements are entirely eliminated.

The procedure consists of using damp chamois skin as the measuring medium. The chamois skin is cut to fit the defect and enough used to reach to the area from which the graft is to be taken. The chamois skin is then cut to represent the proposed flap. It is then swung into position onto the healthy skin and its outline traced on the skin with 10 per cent silver nitrate. When the patient is ready for operation therefor, the black outline of the silver nitrate indicates the line of incision and enables one to prepare the skin

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without fear of destroying the markings. The graft may be made under local anesthesia if desired without the measurements being distorted. It is necessary to apply the silver nitrate long enough before the operation to allow it to turn black. The same procedure may be used in performing plastic operations where shifting, *etc*, of the skin is involved.

It has been found that moist chamois skin may be manipulated the same as human skin and therefore, gives the operator accurate information not only as to the measurements but also how much tension will exist at the end of the operation. This information is very essential in order that the sutures will not be under tension and also to guard against constriction of the blood supply.

Figures 1, 2 and 3 illustrate the employment of this procedure. Due to the injury, the skin of the bridge of the nose was all scar tissue and the bone



FIG 3—Showing skin flap in place



FIG 4—After repair was completed

was entirely missing. The area to be covered was marked off and the chamois cut to fit, allowance being made for the bone graft that would eventually be placed under the skin to build up the bridge. The bone graft form was determined by making a cast of the defect with molding wax. The chamois was then placed on the forehead and the position shifted until a flap could be turned down without constriction of the blood supply and without tension. The outline of the moist chamois was then marked off upon the forehead with silver nitrate. The following day the operation was performed, the skin flap fitting perfectly. Ten days later, the graft was cut from the flap and the flap returned to the forehead. By stretching it no skin defect of the forehead resulted. Several months later the bone graft was inserted completing the restoration of the nose (Fig 4).

# MEMOIRS

JOHN FOX CONNORS

1873-1935

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JOHN FOX CONNORS was born in Tipperary, Ireland, on October 26, 1873, and died in New York January 5, 1935. He received the degree of



JOHN FOX CONNORS, M D

B A from St John's College in Brooklyn in 1892, and the degree of M D from the University of New York in 1895. He served on the house staff of Charity (now Metropolitan) Hospital and from 1898 to the day of his death

was engaged in the practice of medicine in New York. In 1892, he received the Master's degree, and in 1929 the honorary degree of LL.D. from his Alma Mater. In 1903 he was appointed visiting surgeon to Harlem Hospital and in 1922, when elected a fellow of the American Surgical Association, he became its surgical director. He was also consulting surgeon to the Stamford Hospital and to the hospital in Waterbury, Conn.

Both as resident, and later as visiting surgeon, Doctor Connors enjoyed a varied and active service, in which major traumatic surgery largely preponderated. This was especially the case in Harlem Hospital which receives a majority of its patients from the adjacent thickly populated Negro quarter, with whom the sudden flashing of the knife or razor, and the use of the pistol is proverbial. This experience was reflected in his contributions to surgery. To minimize the danger of uncontrollable hemorrhage in stab wounds of the chest he advocated prompt and wide exploration with the ligation of a possibly divided internal mammary or intercostal artery, and in the abdomen he reported a large number of lesions of the spleen and other important abdominal viscera. His contributions to the treatment of empyema were also noteworthy.

"Jack" Connors was intensely proud of his nationality. During the customary annual dinner some years ago of the American Surgical Association, the singing of the "Wearing of the Green" by one of the invited guests was preceded by a request for any Irishman to make his presence known. Immediately "Jack" Connors stood up, and as quickly resumed his seat amidst the applause of his colleagues. He possessed the virtues of those who hail from the "Emerald Isle" with none of their vices. He was a politician, not so much to advance his own interests as those of his friends. Once a friend, always a friend, most cordial and anxious to be of service to his fellow man, and never animated by a spirit of revenge or enmity.

His surgical skill was of a high order, both in actual therapy as well as in surgical technique and judgment. His loss is keenly felt by many friends, who will always affectionately remember him. What greater tribute could one wish to leave as a heritage?

ELLSWORTH ELIOT, JR



## FRANCIS STUART MATHEWS

1869-1936

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IN THE death of Francis Stuart Mathews on February 17, 1936, the surgical profession of New York City lost one of its outstanding members,



FRANCIS STUART MATHEWS, M.D.

a man combining ripe experience and rare skill with a lovable, inspiring character

He was born in Washington, Pa., on November 14, 1869. His father, William Johnston Mathews, a storekeeper, came from a family of Scotch-Irish Presbyterians who had been settled in Pennsylvania for several generations. His mother, Frances Sage Pelletreau Mathews, was of Huguenot stock, whose ancestors had emigrated to Southampton, Long Island, following the massacre of St. Bartholomew. A forbear in whom Doctor Mathews took particular interest was his great-grandfather, Elias Pelletreau, a colonial silversmith of Southampton, examples of whose work are on exhibition in the Metropolitan Museum of Art in New York City.

When Doctor Mathews was five years old his father died and his mother with her four children went to live with an uncle in the little pioneer community of Prairie du Sac, Wisconsin. There he attended the district school in winter and worked on his uncle's farm in summer. During this period he developed an interest in birds which remained a lifelong source of study and pleasure.

At the age of 14 he was sent back to Pennsylvania to attend preparatory school and college. After taking his bachelor's degree from Washington and Jefferson in 1890, he entered the College of Physicians and Surgeons, New York City, and was graduated in medicine in 1893. The next three years he spent at Roosevelt Hospital, the first two on the surgical service of Dr. Charles McBurney and the third as resident on the gynecologic service.

With the background of a devout home, a youth in which there was a full share of plain living and hard work, and an excellent medical education, he was ready to start practice.

For 12 years he worked in the gynecologic clinic at Roosevelt Hospital. He also assisted the late Dr. Edwin B. Cragin in private practice. When Doctor Cragin ultimately offered to make him an associate at the Sloane Hospital for Women, it was a difficult decision for Doctor Mathews, as its acceptance meant limiting himself to this specialty. He chose to remain in general surgery, but the experience gained in gynecology stood him in excellent stead throughout his subsequent career.

At the outset of his practice he was appointed assistant surgeon at St. Mary's Free Hospital for Children. Within a short time he became pathologist as well, a post he held for eight years. The training gained in this position as well as at the Woman's Hospital, where he worked in pathology for two years, gave him a grounding which few surgeons acquire.

He continued on the staff at St. Mary's, becoming attending surgeon, a position he held until the hospital closed its doors. After he had been in practice five or six years he was made an assistant surgeon at General Memorial Hospital and some years later at St. Francis Hospital in the Bronx.

These latter two positions he relinquished when, in 1913, he was appointed to the surgical staff at St. Luke's Hospital. This was a fortunate move both for St. Luke's and himself. His growing reputation added to the prestige

of the hospital while he in turn found a congenial field and fuller scope for the development of his career. His private practice, already well established, increased steadily with a large following among both profession and laity.

The intense activity of these fruitful years was interrupted by beginning attacks of angina pectoris eight years before his death, when he was 58 years old. From this time on he gave up routine ward duty, but in spite of several periods of absence from work on account of ill health he retained a large practice and was in increasing demand as a consultant.

Doctor Mathews maintained a connection with his alma mater, the College of Physicians and Surgeons, first as instructor in gynecology, and later as clinical professor of surgery.

His achievements were recognized by membership in the New York Surgical Society, which he served as president, the American College of Surgeons, the Interurban Surgical Society and the American Surgical Association.

As a surgeon, Doctor Mathews had an eminently rational and scientific point of view and was never led away by fads of the moment. His judgment was sound and his conclusions, based on broad knowledge and large experience, often seemed intuitive to his assistants. He was never one to operate first and diagnose afterward, but on the other hand made up his mind promptly and boldly, where boldness was called for. He was a deft, practically ambidextrous operator, never seeming to hurry but finishing in a minimum of time. His incisions were moderate in size, the work to be done was accomplished as simply as possible without fussiness or hesitation and, as a result of gentle and expeditious handling, the patient usually made a notably uneventful convalescence.

Doctor Mathews was a frequent, although not voluminous contributor to surgical literature. His papers, covering a variety of subjects, are full of sound observations and comment and well repay rereading. Among the earlier ones is that describing his method of finger enucleation of the tonsil, developed at St. Mary's Hospital for Children at a time when tonsillectomies were frequently incompletely done. Among his later papers are two studies from his experience in the surgery of breast cancer which, thanks to the painstaking and almost complete follow up which he was able to make, as well as the uniform method of treatment carried out throughout the extensive series, are most satisfactory and authoritative contributions to the subject.

His interest in historic medicine was evidenced by a delightful paper on John of Arderne, and in the month before his death he gave no less than three talks on cultural medicine before different groups.

People trusted Doctor Mathews because of his integrity. They knew that his judgments were based on the merits of a case without consideration of self interest. They loved him because of his humanity, kindness and devotion to their interests. The physicians who depended on his help in

their surgical problems, and the patients who benefited from his ministrations, were alike enthusiastic in his praise

His professional success depended not one iota on pushing aggressiveness. On the contrary, he was modest and retiring and the hospital appointments and honors which came to him were offered in recognition of his abilities and not sought out. He completely lacked the egotism and acquisitiveness which characterize many successful men, but strove rather to share opportunities and push the interests of those associated with him.

This thoughtfulness for others and desire to help them was one of his outstanding characteristics. He was always ready to assist a younger colleague in a case, if by this support the patient could be satisfied, rather than have him fall into his own hands. On his hospital service he saw to it that his assistants had as many and as interesting cases as it was possible to pass on to them.

One of Doctor Mathews' most delightful qualities was his keen sense of humor with which his conversation sparkled. He was a man of broad culture and could quote the Bible and Shakespeare in an inimitable way.

Although he was devoted to his profession and found his chief joy in it to the day of his death, he had other interests. Reference has already been made to his knowledge of birds. This was enhanced by trips to the West Indies where the bird life attracted him as well as the history of the Islands. He took a keen interest in the American Museum of Natural History where he was named research associate in experimental biology. He was a deacon in the Presbyterian Church.

In 1923, his alma mater, Washington and Jefferson, conferred on him the degree of Doctor of Laws.

His wife, the former Miss Julia E. King, of Columbus, Ohio, survives him as do their three children. He was fortunate in having his older son, Dr. Frank P. Mathews, associated with him in practice during his last years.

On February 17, 1936, after his usual hospital visit in the morning, he was examining a patient in the office when stricken with an attack of coronary thrombosis. He was relieved of pain by sedatives and was apparently resting comfortably that evening, when, in the midst of a conversation with his physician he suddenly died. It was an ending which one might envy, yet with his splendid faculties unimpaired, how much there is to regret that he could not have been spared a longer time.

MORRIS K. SMITH

## MALCOLM LASALLE HARRIS

1862-1936

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MALCOLM LASALLE HARRIS died in the Milwaukee Sanitarium at Wauwatosa, Wisconsin, on March 22, 1936, following a long illness resulting from a cerebral hemorrhage and secondary complications. Doctor Harris was



MALCOLM LASALLE HARRIS, M.D.

born June 27, 1862, in Rock Island, Illinois, the son of Samuel G. and Frances Green Harris. He attended the public schools in Iowa and in 1882, when he was 20 years old, was graduated from Rush Medical College. After

serving his internship in the Cook County Hospital, he began practice in Chicago in 1884, where he continued to reside up to the time of his death, teaching in the County Hospital and also serving as Professor of Surgery in the Chicago Polyclinic

Following reorganization of the American Medical Association in 1901, Doctor Harris became a member of the House of Delegates and served the American Medical Association continuously in various capacities up to the time of his incapacity due to illness. He had been successively a member of the House of Delegates, a member of the Board of Trustees, and Chairman of the Judicial Council. He was elected President of the American Medical Association in 1928, serving during 1929 and 1930. He had previously, 1898-1899, been secretary of the Section on Surgery and Anatomy, at a time when Dr. William J. Mayo was chairman of the Section. He was a member of the Board of Trustees of the American Medical Association from 1903 to 1918, and a member of the Judicial Council from 1918 to 1928.

As a surgeon, Doctor Harris had been honored with membership in the International Surgical Association, the American Surgical Association, the Western Surgical Association, and the American Association for Clinical Surgery. He served as President of the Chicago Medical Society, the Chicago Surgical Society, the Chicago Pathological Society, and the Western Surgical Association. At the Henrotin Hospital he served as Secretary of the Board continuously from 1889 to 1935 and was instrumental in the financing and construction of the new Henrotin Hospital. His contributions to medical literature include not only the translation and editing of Braun's "Local Anesthesia," and contributions to the Oxford, Keen's and Bryant's "Systems of Surgery," but also many periodical contributions not only in surgery but also in the field of medical education and more recently of medical economics.

His knowledge of the literature of surgery was catholic and his discussion of surgical questions was precise and illuminating and devoid of loose thinking and generalization. During his many years of service at the Cook County Hospital his work was eagerly attended by the younger members of the staff who recognized in him a surgeon of unusual skill and seasoned judgment. Doctor Harris was elected to membership in the American Surgical Association in 1900 and continued in active membership until the year preceding his illness. He will be greatly missed by his colleagues and many friends, for he was a man of wide acquaintanceship and recognized everywhere as a capable leader in medical, civic and financial affairs.

VERNON C. DAVID

## LEONARD FREEMAN

1860-1935

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ON DECEMBER 16, 1860, there was born to Dr. Zoeth Freeman and Ellen Rickett Freeman at Pine Grove, near Cincinnati, Ohio, a son Leonard Dr.



LEONARD FREEMAN, M.D.

Dr. Zoeth Freeman practiced medicine in Cincinnati for years, and later became the personal physician to President U. S. Grant. During the years of his

Presidency they, with their son Leonard, lived in Washington. These years of residency in Washington during the stirring post-war period were a stimulating influence to the youthful Leonard.

Leonard Freeman received his primary education from tutors and in private schools. In 1882, he was graduated from the University of Cincinnati with the degree of B.S. In his youth he became interested in archeology, an interest he retained throughout his life. He studied ornithology with Charles Drury, a prominent naturalist of Cincinnati, whom he accompanied on several field trips, the most extended being a summer spent in the Everglades, Florida. His early studies made him a keen observer, a faculty he further developed and which later became valuable in the practice of his profession. An example of the correlation of his ornithologic and surgical observations is found in his comparison of the normal stomach of a granivorous bird with the stomach in congenital pyloric stenosis, an original, plausible explanation of the baffling etiology of this condition. (*Colorado Medicine*, vol. 20, p. 78, March, 1913.)

Fond of the out of doors, a lover of nature imbued with the spirit of adventure, he was prompted to take many trips into the wilds of Michigan and Canada. Over fifty years ago with two classmates, Otis Cameron and Fred Sampson, he made a canoe trip from Cincinnati up the Miami and Erie Canal to Lake Erie, thence through the Great Lakes to Duluth, Minnesota, truly an undertaking worthy of a "Voyageur."

He studied medicine at the Medical College of Ohio where he took his medical degree in 1885. He served as intern in the Cincinnati Hospital. The next three years were spent abroad at the University of Göttingen. He studied pathology under Virchow, bacteriology with Koch, and then pursued postgraduate clinical work in Vienna and Berlin.

Returning to Cincinnati he taught pathology and bacteriology in the Ohio Medical College and served as pathologist and bacteriologist to the Cincinnati Hospital from 1889 to 1891. During these years he was associated with Dr. Phineas S. Connor, then one of the ranking surgeons of the United States.

In 1891, his health broke and he went to Colorado. On regaining his strength he took a sea voyage on a sailing vessel to Honolulu. While in the Hawaiian Islands he spent some time in the Leper Colony at Molokai. On his return to Cincinnati, in 1894, he married Miss Amanda Frank. In 1895, he went to Denver, Colorado, to live. They had three sons: Frank, the eldest, an engineer living in Denver; Paul, who died in 1917; and Leonard, Junior, a surgeon who was associated with his father. His wife died in 1904. In 1906, he married Miss Jean Wright of Denver.

In 1897, Doctor Freeman became a member of the faculty of the Denver and Gross Medical College and continued to serve on the faculty when that school merged with the University of Colorado. For years he was professor of surgery and Head of the Department of Surgery of the University of Colorado Schools of Medicine.

On December 27, 1935, Dr. Leonard Freeman died of coronary thrombosis at his home in Denver, Colorado. A long, active, and productive professional career was closed at the age of seventy-five, after an illness of but



a few days From the day of his graduation from the Medical College up to the day of the onset of his brief but fatal illness he assiduously studied, and impressively taught, practical surgery

Dr Freeman was a man of vigorous and powerful physique, possessed of the spirit and determination of the true pioneer Cast in a big mold, bigness was expressed in his every thought and deed Unostentatious, guileless, devoid of pettiness and self-aggrandizement, he could not comprehend the absence of these qualities in others, therefore he was frequently imposed upon by those less sincere and less frank

A man of strong convictions, he not only conceded but defended the right of others to enjoy the same privilege His brusque manner was but a superficial affectation, a defense reaction to mask a sensitive nature and a big tender heart Only those who really knew Doctor Freeman could realize how easily he was moved and how deeply he could feel He had schooled himself in the control of his soul-stirring emotions He was the personification of honesty, the soul of honor and justice, aggressive and courageous, a staunch defender of the weak and a champion of the righteous

Doctor Freeman was an ardent student of primitive as well as contemporaneous surgery, both foreign and American Blessed with an analytical, receptive mind and an unfailing memory, with his splendid training in pathology and bacteriology, it was but natural that he became and was for many years one of America's outstanding resourceful surgeons

He was a keen observer, a clear and logical thinker and a forceful, terse speaker What he said or whatever he did was based upon knowledge and personal experience In his studies, writing, teaching, consultation, operations and discussions he demonstrated a rare faculty of grasping essentials He faced facts He was authority

Doctor Freeman was a world traveler On numerous journeys through Europe, Central and South America, on voyages to Japan, China, the Philippine and South Sea Islands he never failed to study the hospitals and surgeons of these often remote countries He availed himself of every opportunity to delve into primitive and aboriginal surgery These studies resulted in several important papers on "Primitive and Aboriginal Surgery" His contributions to surgical literature were numerous, of wide range and valuable

He was ex-president, a consistent attendant, and a stimulating scientific contributor of the Denver Clinical and Pathological Society, the Medical Society of the City and County of Denver, the Colorado State Medical Society and the Western Surgical Association He was an enthusiastic member of the American Surgical Association He was also a member of the International Surgical Association and the American College of Surgeons

The high regard with which Doctor Freeman is held throughout the West is evidence of his excellent surgery and his stimulating influence on the vast number of his former students and the younger members of the profession

Doctor Freeman is dead, but the memory of so great a surgeon, so inspiring a teacher, so true a man, and such a loyal friend can not die

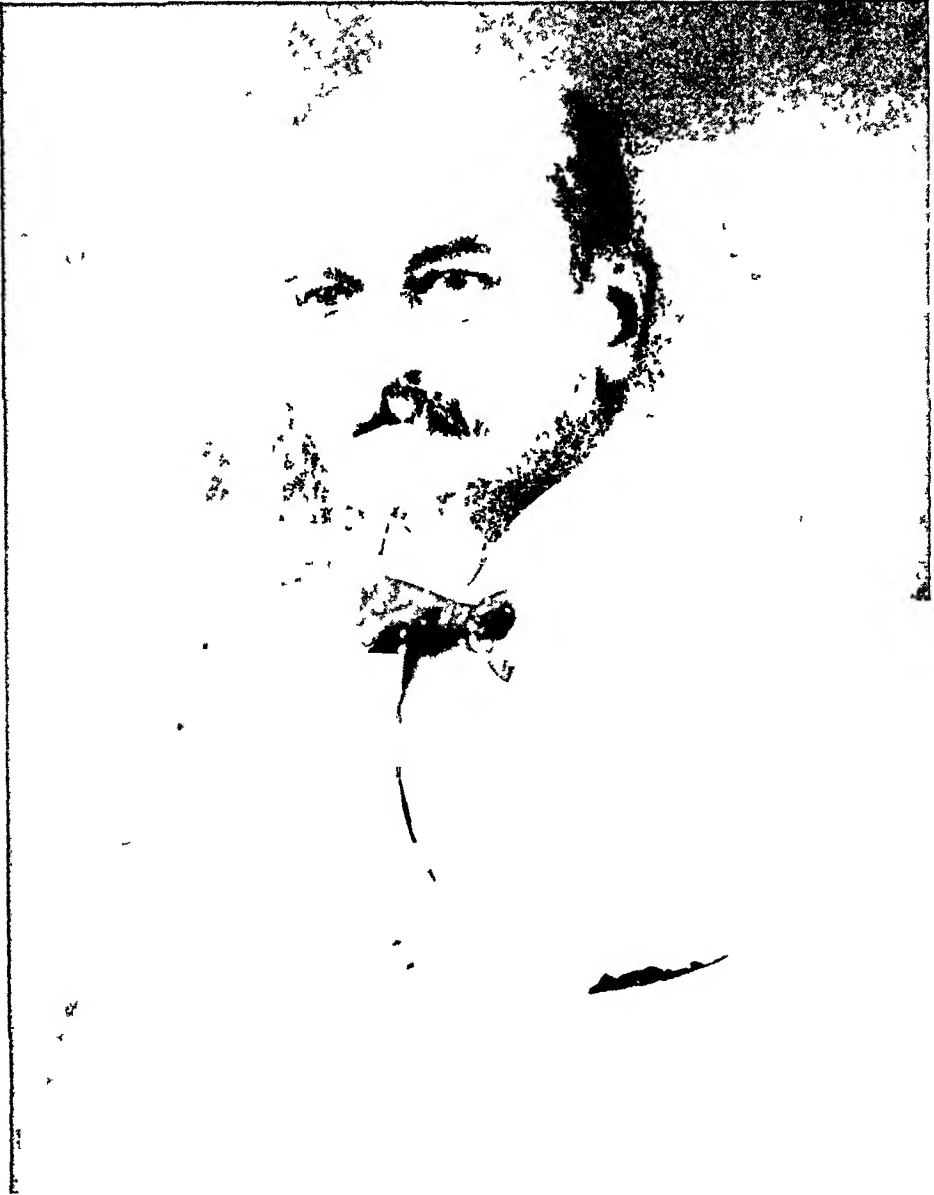
CASPER F HEGNER

## WILLIAM JOHNSON TAYLOR

1861-1936

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WILLIAM JOHNSON TAYLOR, a Fellow of The American Surgical Association since April, 1887, died at his home in Philadelphia January 22, 1936



WILLIAM JOHNSON TAYLOR, M.D.

He was born in Worcester County, Md., October 13, 1861. He was graduated from the Medical School of the University of Pennsylvania in 1882

and then served a two year internship at the Pennsylvania Hospital. A few years later he became Assistant to W. W. Keen in his private work and at the Orthopedic Hospital and Infirmary for Nervous Diseases. It was at this hospital that S. Weir Mitchell and W. W. Keen developed a large neuro-surgical clinic and Taylor was Keen's right-hand man from that time until the latter's retirement. He thus assisted Keen in all his early brain operations. Later he succeeded Keen as surgeon to the hospital. Doctor Taylor served the Orthopedic Hospital continuously and conscientiously for 50 years, a service which was gratefully acknowledged in 1935 by both the Board of Managers and the Staff of the hospital. In addition to his service at the Orthopedic Hospital he was for many years surgeon to St. Mary's and St. Agnes' Hospitals.

Doctor Taylor was what might well be styled a sane surgeon. He was well trained in the art and was a capable and conscientious operator. He was held in very high regard not only by his friends and colleagues but also by the general profession, largely because of his fine character and his well known stand on matters relating to professional and educational standards.

His greatest professional interest was the College of Physicians. He served this institution for a long period of years on various committees and conspicuously on the Building and Finance Committees. He was made President of the College in 1909 and occupied the chair for three years. He was very active in the Philadelphia Academy of Surgery, being Secretary for many years and President in 1908-1909.

An interest outside of medicine to which he gave a great deal of his time was the Philadelphia Library, an old and honorable institution founded by Benjamin Franklin. Doctor Taylor was President of the Board for two years.

When the United States entered the World War, Doctor Taylor was 56 years of age. He accepted the rank of First Lieutenant and went to France with the Pennsylvania Hospital Unit, Base Hospital No. 10, which on arrival in France was assigned to the British service and given General Hospital No. 16 at La Tréport. He was with this Base Hospital throughout his service and was advanced to Captain September 10, 1917, and to Major January 9, 1918. On November 11, 1918, he was made Lieutenant Colonel. His war service was characterized by the same earnest enthusiasm that was conspicuous in his professional life both before and after the War.

Sympathy, kindness and consideration of others were outstanding characteristics of William Johnson Taylor. In 1891, Doctor Taylor married Miss Emily Buckley Newbold and she with their four children survive him.

JOHN H. GIBBON

## JAMES TATE MASON

1882-1936

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By THE death of James Tate Mason on June 20, 1936, the surgical profession lost one of its most energetic and lovable characters. Doctor Mason was born at Lahore, Orange County, Virginia, on May 20, 1882. His grand-



*McBride Studio*

JAMES TATE MASON, M D

father, Captain Claiborne Rice Mason was one of Stonewall Jackson's engineers during the Civil War and later was instrumental in building the Virginia Midland Railroad, in addition, he constructed the greater part of the Chesapeake and Ohio line. Doctor Mason's father, Dr. Claiborne Rice Mason, also served under Stonewall Jackson until wounded and taken to Elmira where he was kept a prisoner of war until the surrender at Appomattox. Doctor

Mason's mother, Mary Moore Woolfolk, was a native of Orange County, Virginia

Doctor Mason attended the Locustdale Military Academy until 1901, when he entered the University of Virginia Medical School, graduating in 1905. During his school and college years, he forecast his later popularity by being greatly in demand among his mates, active in athletics, a natural leader, he was a favorite with both schoolfellows and instructors. During the summer vacations he served as an assistant to Colonel James A. Frazier, owner and manager of the Rockbridge Alum Springs, thus cheerfully helping to make his way through school. Following his graduation in 1905, he passed the examination of the Virginia State Medical Board in Richmond and began a Junior Internship in the Philadelphia Polyclinic, now known as the Post-Graduate School of the University of Pennsylvania. A residency at the Municipal Hospital of Philadelphia followed.

In the spring of 1907, as ship's surgeon, Doctor Mason came around the Horn and arrived in Seattle in the summer of the same year. Shortly thereafter, he became surgeon for the Pacific Coast Coal Company with mines at Franklin and Black Diamond, and in Franklin he did general practice for two years, making—as he did throughout his life—many staunch friends. In 1909 he moved to Seattle and shortly thereafter became physician to the county jail and, two years later, Coroner of King County. In 1914 he was appointed superintendent and Chief Surgeon of the King County Hospital which position he held until 1920.

On January 3, 1912, he married Laura DeWolfe Whittlesey of Seattle. Mrs. Mason and three children, James Tate Mason, Mary Virginia Mason and Frederick DeWolfe Mason, survive him.

In 1917, Doctor Mason and his colleagues began the association which culminated in the Mason Clinic, and within two years they organized and built the Virginia Mason Hospital of which he was Chief Surgeon and President at the time of his death.

From 1923 to 1926 he served as Secretary of the Section on Surgery, General and Abdominal, of the American Medical Association, and was Chairman of that section for one year. Between 1928 and 1934 he was a member of the House of Delegates, and during the year prior to his death, he was active in fulfilling the obligations of President-elect of the American Medical Association. His death followed some five weeks after the unusual honor of his installation in absentia to the office of President.

In addition to his local societies, Doctor Mason was a regular attendant at the meetings of the Western Surgical, Southern Surgical and Pacific Coast Surgical Associations. He was a Fellow of the American College of Surgeons and was elected to membership in the American Surgical Association in 1930. He served as President of the American Association for the Study of Goiter and of the Pacific Coast Surgical Association.

His death occurred at the Virginia Mason Hospital in Seattle on June 20, 1936, the result of endocarditis with multiple emboli.

His affiliations bear witness to his lively interest in and enthusiasm for all things surgical, and to his executive ability as well. They can give no picture, however, of his love for people which was perhaps his outstanding characteristic. His companionability was felt by all, even though their contacts with him were brief. His adaptability, keen memory for faces and names, genial manner, ready speech and an inexhaustible fund of Southern stories, all combined to endear him to a huge circle of friends. Able surgeon, executive and administrator, friend to many, his death leaves a gap in the surgical profession.

HOWARD C. NATTZIGER

#### EDITORIAL ADDRESS

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# ANNALS OF SURGERY

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## SYMPOSIUM

ON

### THE INJECTION TREATMENT OF HERNIA

AT

THE UNIVERSITY OF MINNESOTA

MINNEAPOLIS, MINN

THE STATUS OF THE INJECTION TREATMENT OF HERNIA

OWEN H WANGENSTEEN, M D

THE AMBULANT TREATMENT OF HERNIA

ARTHUR F BRAIRUD, M D

AN EVALUATION OF THE RESULTS OF THE INJECTION  
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THE INJECTION TREATMENT OF HERNIA

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STERILITY FOLLOWING THE INJECTION TREATMENT OF HERNIA

CHARLES E REA, M D

# THE STATUS OF THE INJECTION TREATMENT OF HERNIA

OWEN H. WANGENSTEEN, M.D.

MINNEAPOLIS, MINN.

FROM THE DEPARTMENT OF SURGERY, UNIVERSITY OF MINNESOTA, MINNEAPOLIS, MINN.

THE injection method of treating herniae which is now almost a century old has been revived within recent years. In France this plan of dealing with inguinal hernia was developed by Velpeau<sup>4</sup> following the designing of the hypodermic needle and its introduction into medical practice. In this country, this management of hernia was advocated by Heaton<sup>3</sup> and Warren<sup>5</sup>. The latter wrote a treatise upon the subject in 1881. This was eight years before an adequate operative technic for the cure of hernia had been worked out in the hands of Bassini<sup>1</sup> and Halsted<sup>2</sup>. Had the principles of asepsis and the necessity for their rigid exercise been as well understood in 1881 as they were in 1889, it is not unlikely that the nonoperative treatment of certain types of hernia would have found earlier acceptance. The rapidity with which surgical measures in that period were applied to a great number of disorders has become familiar to all who have a reading acquaintance with the development of surgical procedures and technics.

The injection treatment of hernia was introduced into the surgical clinic of the University Hospital by Dr. A. F. Bratrud in 1931. Its employment has since continued here in the hands of a small group. Dr. C. O. Rice of this department, with the permission of Dr. A. A. Zierold, Chief of the Surgical Staff at the Minneapolis General Hospital, instituted this nonoperative method of dealing with selected herniae there. Anyone who manipulates a novel or new therapeutic measure in medicine owes an obligation to the profession to report his unprejudiced appraisal of its merit. In the years which have intervened since the injection method of dealing with herniae was first used in the departmental surgical outpatient clinics, certain impressions have been formulated concerning the faults and virtues of the method. It is the purpose of the accompanying papers to relate those experiences.

It has been found that a large proportion of the patients with indirect inguinal hernia who report to these two outpatient surgical teaching clinics of the University of Minnesota can be dealt with satisfactorily in the ambulatory fashion described in the papers by Drs. Bratrud, McKinney, and Rice. It is important, as they point out, that the surgeon have the full cooperation of the patient. It is also apparent that only *reducible* herniae are suitable for injection, proper retention of the hernia by a suitable truss is mandatory *before* the injections are instituted. The selection of *appropriate* cases is extremely important. The small reducible, indirect inguinal hernia in the young person with strong tissues seems most suitable for this method of



treatment. An anxiety to extend the method to cases that present large defects and poor tissues results in a large incidence of failures. It would appear likely that the cure of hernia effected by parasaccular injection will be followed by a somewhat higher incidence of late recurrence than after the operative method in which hernioplasty is also done in addition to obliterating the hernial sac. Satisfactory results have been obtained in some direct herniae as well as in isolated instances of patients with femoral, umbilical, and epigastric herniae.

It is generally admitted that the operative treatment of hernia is only to be assumed by those who possess an adequate acquaintance with surgical technic and knowledge of the anatomy of the abdominal wall. He who undertakes the injection method of treating inguinal hernia should possess ready familiarity with the anatomy of this region. The injection of sclerosing solutions into the abdominal wall by persons not well oriented in the surgical anatomy of the groin or not possessed of an intimate knowledge of the technic of the method is as *hazardous* as the operative method in hands which have not been trained. Skill is as important a determinant for success with the employment of this method as it is in the operative treatment of hernia. Unwarranted zeal on the part of enthusiasts of the injection method of dealing with hernia to extend its use to cases which are obviously not suitable or amenable to cure by this means will not only retard its acceptance by the profession, but will serve to discredit the method as much as its employment by unqualified persons.

The method, like any operative procedure, is not free from complications even in practiced hands as the accompanying papers attest. It is not without significance, however, that not one patient of the several hundred treated by this method in the two surgical clinics has died as a direct result of the treatment. As much can rarely be said for large series of similar size treated by operation. This method of treating selected cases of hernia has merit and when skilfully employed would appear to carry little risk of serious complication.

Medicine has come to recognize the superiority of trial over reason. Rationalizations concerning the merits of a method are likely to lead to error, not so much because the logic employed is poor but more often because the initial premise itself is false. The injection treatment of hernia is not therefore to be dismissed without examination. The rejection of obliteration of hemorrhoidal varicosities and varicose veins of the lower extremity by injection is fresh enough in the recollection of medical men to remind them that prejudices cannot delay the march of progress.

Time will ultimately judge impartially of the merits of the injection method of treating herniae. Surgeons are, I believe, not more objective than any other group of medical men. They know well the anxiety that the contemplation of an anesthetic and an operation provokes in the minds of most patients. When the question of the best sclerosing agent has been settled and the technic of the procedure has become better standardized, and when

sufficient trial in practiced hands has adequately shown that selected herniae can be satisfactorily treated by injection without recourse to operation, surgeons generally will probably welcome this means as a valuable addition to acceptable methods of dealing with hernia

## REFERENCES

- <sup>1</sup> Bassini, E Ueber die Behandlung des Leistenbruches Arch f klin Chir, 40, 429, 1890
- <sup>2</sup> Halsted, W S Radical Cure of Inguinal Hernia Bull Johns Hopkins Hosp, 1, 12, 1889
- <sup>3</sup> Heaton, G The Cure of Rupture, Reducible and Irreducible J H Davenport, Editor Houghton, 1877
- <sup>4</sup> Velpeau, A A L M New Elements of Operative Surgery Translated by P S Townsend 3, 554 New York, Wood, 1847
- <sup>5</sup> Warren, J H A Practical Treatise on Hernia Boston, J R Osgood & Co, 1882

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## THE AMBULANT TREATMENT OF HERNIA

ARTHUR F BRATRUD, M D

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INTEREST has been manifested at various times in the past concerning the ambulant treatment of hernia, but it has never become popular. As early as 1880, Billroth made the statement that if anyone could obtain a solution that would cause the artificial proliferation of tissue that would be as dense and tough as fascia, the radical cure of hernia would be solved. Apparently Velpeau,<sup>18</sup> of Paris, must be given the credit for being the first surgeon to use nitants with the idea of producing a proliferation of new connective tissue to obliterate the sac of an inguinal hernia. He reported several cases as being successfully treated by the injection method. In 1842, Heaton,<sup>7</sup> in Boston, treated a few cases by the use of tincture of iodine. It was not until 1877 that he published a book describing his treatment. Due to the fact that Heaton would not divulge the exact technic to the medical profession, his work never received official recognition. After the publication of Heaton's book, Warren<sup>19</sup> of Boston, who was associated with Heaton, later published a book on the Treatment of Hernia. Other men who contributed to the early literature should be mentioned, notably Schwalbe, Janney, Lannelongue,<sup>10</sup> Ripley, Coe, McDonald, and Mayer.<sup>11</sup> On account of the numerous complications and the fact that the work was not performed by able surgeons, the treatment received a great deal of criticism.

During the past five years the writer has endeavored to perfect a method to cure certain herniae by the injection of sclerosing solutions. The purpose of this paper is to present the results of animal experiments as well as the

clinical impressions and results obtained from the application of the method to outpatients

EXPERIMENTAL WORK —Various solutions have been employed in experimental work on dogs and rabbits, as well as in the treatment of herniae in patients. The formulae for solutions which the writer has used to date are as follows

Phenol-Thuja Mixture

Phenol	50 parts
Alcohol	25 parts
Lloyd's specific tincture of thuja	25 parts

Allow to stand two days and then either decant or filter

Mayer's Solution

Zinc sulphate	1 dr
Phenol crystals	6 dr
Glycerin	4 fl dr
Aq cinnamomi	1 fl oz
Fl ext pinus canadensis (dark)	5 fl dr
Sterilized chemically pure redistilled water	2 fl oz

Dissolve the zinc sulphate in the cinnamon water. Liquefy the phenol crystals by heating. Add the glycerin. Shake thoroughly until mixed and cooled, then add the distilled water and finally the fluid extract of pinus canadensis. Shake thoroughly. Allow the fluid to stand for about a week, agitating the mixture several times a day. Subsequently it should be filtered. Before injecting, boil the solution in a glass tube.

Other solutions which have been used in experimental work are oleic acid, quinine urea, in strength up to 3 per cent, Pina Mestie solution, Proliferol, which is a distillate of several botanical drugs to which have been added tannic acid, benzol alcohol and thymol in various strengths up to 1 per cent, allantoin, cystein, ethereal oil of thuja, fluid extract pinus canadensis in strengths of 1, 3 and 10 per cent, and psyllium seed extract.

For the experimental work various solutions in quantities of three minims up to 3 cc were injected below the fascia of the rectus abdominis muscle as well as into the abdominal cavity and subperitoneal tissue of dogs and rabbits. Injections were made about twice a week. A few solutions produced no proliferation at all while other solutions produced a marked proliferation of fibroblastic tissue. When the phenol-thuja mixture, Proliferol, Pina Mestie solution, Mayer's solution, or ricinoleate solutions were used, the tissues showed marked induration and thickening. All tissues showed an early necrosis before fibroblasts appeared which permeated the muscle fibers. This, according to Dr. E. T. Bell, Professor of Pathology at the University of Minnesota, "Produced a binding effect." There was no late infiltration of polymorphonuclear cells, or any evidence of late necrosis. A few days after the injection of the solution there was an infiltration of polymorphonuclear cells with necrosis varying according to the strength of the solution used. Fat necrosis was present in the muscle when ricinoleate solutions were

used When the solution was injected into the peritoneal cavity, the omentum became very adherent at the site of injection, the fibroblastic tissue having completely obliterated the peritoneum. Loops of bowel were very adherent, but no obstruction was present. Pina Mestre solution produced necrosis which seemed sufficient to contraindicate its clinical use. With the original Pina Mestre solution there was found a marked proliferation of fibroblastic tissue with foreign body giant cells. A solution consisting of a distillate of the tinctures reported to be in the formula for the original Pina Mestre solution was used. To this was added tannic acid in standardized strengths, varying from 0.15 to 1 per cent, as well as thymol 0.5 per cent and benzol alcohol 3 per cent. This produced a marked proliferation of fibroblastic tissue. The proliferation did not begin as early as that following the injection of the phenol-thuja mixture, which could be seen as early as the fourth day. A number of dogs were injected with fluid extract *pinus canadensis* in alcohol and phenol, in strengths of 1, 3, and 10 per cent. These are the basic drugs in Mayer's solution. They produced necrosis, abscess, and in one dog, peritonitis and death. The proliferation of fibroblastic tissue is more marked than in the specimens following the injection of the distillate mixture. No giant cells were found. Sections of tissues following the injection of tannic acid mixtures showed a dense fibrosis. Injection close to the peritoneum or just within the peritoneal cavity showed no evidence of abscess or necrosis, but a similar picture. The omentum was adherent to the abdominal wall, and there was so much proliferation of fibrous tissue as to completely obliterate the peritoneum. Results of injection below the fascia of dogs and rabbits showed a marked proliferation of fibroblastic tissue with no evidence of late necrosis, or infiltration of polymorphonuclear cells. However, polymorphonuclear cells are present when proliferation is first noticed, which is about the fourth day. Sections from dogs injected with the original Pina Mestre solution, as well as the distillate of the drugs contained in the formula, showed a reaction which could hardly be differentiated one from the other except that the section from the original Pina Mestre solution showed better developed foreign body giant cells. There was no late infiltration of polymorphonuclear cells or necrosis in these specimens. Injection of allantoin in strengths of 0.25 to 1 per cent, cystein 1 per cent, or oleic acid, produced no fibroblastic proliferation at all. Where psyllium seed extract was used, there was quite marked early necrosis as contrasted with the tannic acid preparations. There was very good fibroblastic proliferation, but there was late fat necrosis in the muscle tissues.

Before treating any patients, colored novocain solution was used to inject the internal inguinal ring, and it was surprising to note how the solution could be deposited around the internal inguinal ring with the technic to be described. The phenol-thuja solution was the first used. On account of the burning that resulted from the injection of an aqueous tannic acid preparation, various local anesthetics, novocain, nupercain, and benzol alcohol were employed. These diminished the burning pain, but a large percentage of

these patients would have symptoms of an acute coryza on the following day. This did not occur in all cases, but in so many that it was discontinued. This was thought to be due to the fact that tannic acid did not exist in colloidal form in the synthetic preparation and was more rapidly absorbed, thus causing toxic symptoms. The histologic change in tissues of the treated patients is the same as that in injected animals. There is always an exudate which varies according to the strength of the solution used. There is more early necrosis with the phenol-thuja mixture than with any of the tannic acid mixtures. However, the fibroblastic tissue which results following the injection of the phenol-thuja mixture is denser and tougher than where tannic acid preparations are used.

**SELECTION OF CASES**—The injection treatment of hernia can be carried out in patients of all ages, provided that the hernia can be completely reduced and held completely reduced by a properly fitting truss during the period of active treatment. Umbilical, indirect inguinal, direct inguinal, and recurrent herniae give the best results. A few femoral herniae can be successfully treated by this method. Postoperative or incisional herniae usually have adhesions or incarcerated abdominal viscera and no definite sac, and should not, as a rule, be so treated. Incisional herniae usually have one hernia that can be diagnosed, but have several potential herniae along the line of the incision. If there has been a very small incision, if a definite opening can be determined, and if the contents can be reduced and held reduced by a properly fitting truss, this hernia can be so treated. Herniae associated with an undescended testicle, and incarcerated or irreducible herniae should not be injected on account of the danger of strangulation. These are distinct surgical conditions. Herniae that can be reduced, but where the symptoms cannot be completely relieved by proper application of a truss, are unsuited for the injection treatment. Sliding herniae should not be so treated. It is very doubtful if a sliding hernia can be held reduced by a truss. Any general surgical contraindication, such as hyperthyroidism and hemophilia, should always be considered a contraindication. Large scrotal herniae give doubtful results, but these cases should be fitted with a truss both before being referred to surgery and after surgical repair. Laying aside the contraindications, it may be said that any inguinal hernia can be treated provided that it is reducible and can be held reduced by a properly fitting truss, and provided there are no surgical contraindications, as mentioned above. If there is any suggestion of an impulse or the hernia comes down occasionally after fitting of a truss, the case should be operated upon, not injected. Although a few femoral herniae have been treated with good results, I believe that there are liable to be complications, especially in large herniae. Several epigastric herniae have been treated with good results. Very often in femoral, umbilical or epigastric herniae, there is a fat pad in the sac. Application of a truss in these cases causes pain. These cases should not be treated unless there is absolute and complete relief of symptoms.

**THE TRUSS**—It is absolutely necessary, primarily, to know how to fit a truss in order to keep the hernia reduced. By holding the hernia reduced the truss keeps the walls of the sac in direct apposition so that when fibroblastic tissue begins to form, the sac is completely obliterated by the new fibroblastic tissue. Should any abdominal viscera be retained within the sac it would be impossible to effect a cure, as any straining would force the contents farther down, separating the walls of the sac. Any type of truss

can be used provided it holds the contents within the abdomen. For a single hernia a spring type of truss is more comfortable than a band type of truss (Fig 1), for it does not have a tendency to move when the thighs are brought forward. A spring type of truss can be fitted to double herniae, although a band type of truss usually gives better results. For umbilical herniae, the best form of truss is a hard pad which fits into the hernial orifice and is held in place with an elastic bandage wrapped around the body several times. There should also be two thin plates which fit over the pad. The first plate should come to the inner edge of the rectus abdominis muscle, and the outer plate should come to the junction of the outer and median third of the muscle (Fig 9b). This is a definite improvement over any previous truss or binder used for

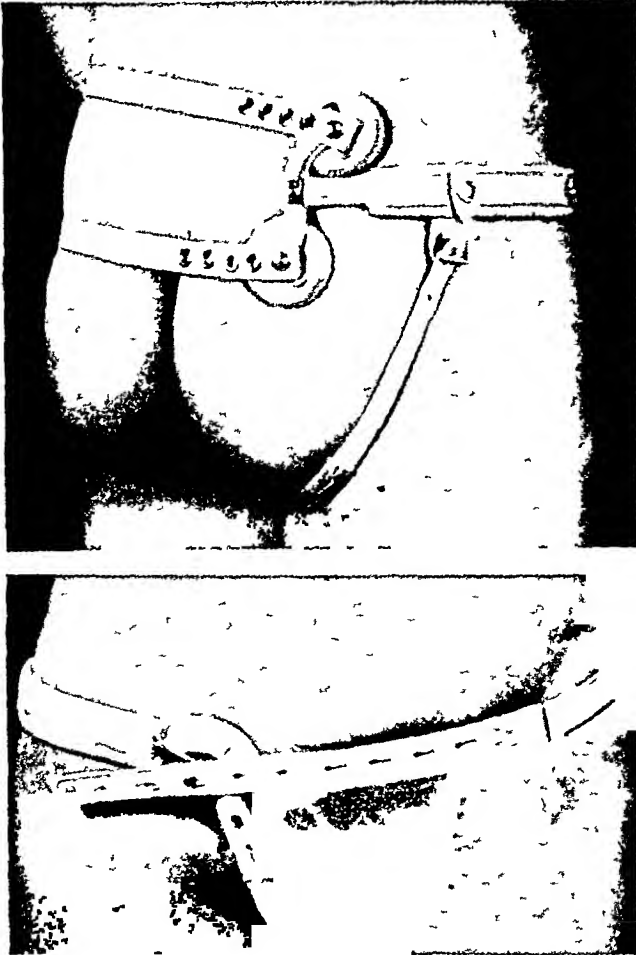


FIG 1—The spring type of truss used in the Hernia Clinic of the University of Minnesota Hospitals. Various types of pads can be fitted to these trusses, and this is of great importance. It is not always necessary to have a large truss pad for a large hernia.

this type of hernia.

Measurements for trusses are taken directly around the body at the level of the hernia, or 2 cm below the crest of the ilium down to the symphysis pubis. Trusses should always be worn a sufficient length of time so that the soreness which results after first applying the truss has completely disappeared. With larger herniae it is advisable to wear the truss a longer period of time, even a month or six weeks, before starting treatment. Patients are advised to wear a truss both day and night during the period of treatment, and as long as one month after the period of treatment is over. An elastic

truss is more comfortable while lying down than any other form. Trusses, when properly fitted, permit the patient to engage in almost any form of exercise or work. They are usually fitted too low, and when so fitted very often give relief, but do not hold the contents of the hernia reduced. They cause the hernial contents to press outward against the fascia of the external oblique, and a resultant fraying or thinning out of the fascia, as well as an enlargement of the defect in the transversalis fascia occurs. Very definite instructions should be given patients in regard to proper fitting and wearing of a truss, and especially with regard to the readjustment of the truss in the event of loss of weight.

**TECHNIC OF PROCEDURE**—The technic for treatment where the phenol-thuja mixture or Mayer's solution is used, is to begin with two to five drops, injecting at the internal ring (Figs 4 and 5). Not over eight minims should



FIG 2—This type of pad is especially useful in indirect inguinal herniae, and in people who are very stout. The thick portion of the pad can be turned either upward or downward. For a direct hernia the thick portion of the pad should always be downward toward the pubis.



FIG 3—This type of pad is especially useful in stout individuals. One side of the pad is much thicker than the opposite side. Very often a hernia can be held with this type of pad on a truss where no other type of pad will hold. This is probably due to the fact that the thick portion of the pad fits along the shelving edge of Poupart's ligament. These pads can be fitted on to almost any brand type of truss.

ever be used at one injection. Injections are made about twice a week, depending upon the reaction of the individual. Should there be much reaction, then the duration of time between the injections is lengthened. After several injections at the internal ring, there is usually sufficient plastic exudate so that the hernia does not come down, even when the truss is removed. Injections are also given at several points along the inguinal canal, just beneath the fascia (Fig 6, needle A). Injections are also given just inside the external ring (Fig 6, needle B), and also in Hesselbach's triangle (Fig 7). For the injection of Hesselbach's triangle, the needle is introduced inside the cord and posterior to it, depositing the solution upon the conjoined tendon or the transversalis fascia.

The number of injections required to close the hernia varies. A few cases have received only four treatments, and had a good result. As many as 20 injections have been given to cases with large scrotal herniae. It is

much better to give more treatments than necessary and be sure of a good closure. There is more reaction or soreness with the phenol-thuja solution or Mayer's solution than with the Proliferol solution. However, the phenol-thuja solution produced more proliferation than the other solutions. With Proliferol, the treatment is started at the internal ring. No more than 2 or 3 cc of the solution should be given at the first treatment, and where the

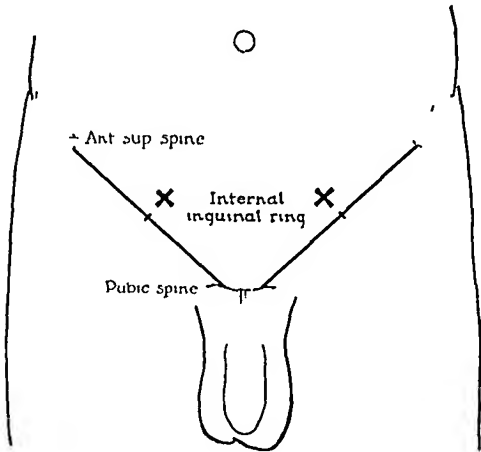


FIG 4—The location of the internal inguinal ring, which is approximately 1 cm above the midpoint between the anterior superior spine of the ilium and the spine of the pubis. This varies according to the size of the hernia, so that in a very large inguinal hernia, where the defect in the transversalis fascia is greater, the ring will extend lower. This location is above the line between the two spines and not along the line.

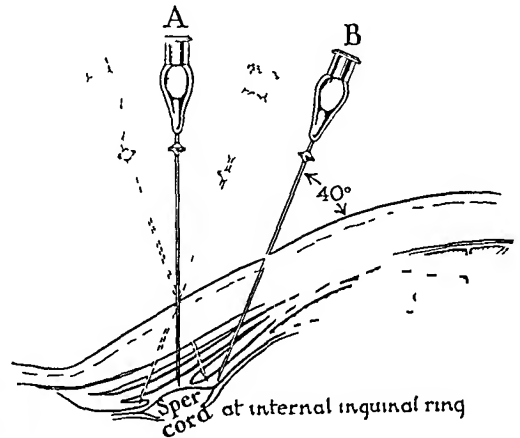


FIG 5—The injection of the internal inguinal ring. The needle A is introduced directly through the skin, fat and fascia of the external oblique muscle. As the needle penetrates the fascia, there is a distinct "give" feeling. Very little experience is needed to determine this location. As the needle is introduced slightly farther, depending upon the thickness of the abdominal wall, it will approach the region of the internal inguinal ring. When the needle is in the proper location, the syringe can be rotated in a circle, thus giving free rotation of the tip of the needle. This can be very easily demonstrated by the injection of colored novocain solution, preparatory to operating upon a hernia. If the needle touches the peritoneum there will be marked pain as the parietal peritoneum is quite sensitive. The internal inguinal ring can also be injected by introducing the needle B at the lateral border of the rectus abdominis muscle, at an angle of approximately 40° to the skin, and penetrating until it meets the resistance of the transversalis fascia.

stronger solutions of Proliferol are used, not over 3 to 5 cc should be used at any time. Injections should also be made at the external ring and along the canal below the fascia so as to completely close the canal. Also Hesselbach's triangle should be treated in all indirect inguinal herniae, so as to protect against a direct hernia.

It is preferable to treat these cases twice weekly, although they can be treated daily with good results. There is much less after-pain or soreness with this solution than with the other solutions. The treatment should be continued until the entire inguinal canal is filled with a plastic exudate which becomes indurated and hard, and until no impulse occurs. It is not advisable to have the patient strain and cough until it is fairly certain that the hernia is obliterated. Occasionally there will be swelling of the cord, but this does not contraindicate treatment at that time. The swelling always subsides in a few weeks. In direct herniae the region of the internal inguinal ring



should be injected to guard against development of an indirect hernia. Where there is a very large external ring, phenol-thuja solution is often used in combination with the distilled mixture. Here the region of the internal ring is injected with the distillate mixture and the phenol-thuja solution is injected at the external ring below the fascia. At the next treatment, the phenol-thuja solution is used at the internal ring, and the distillate mixture at the external

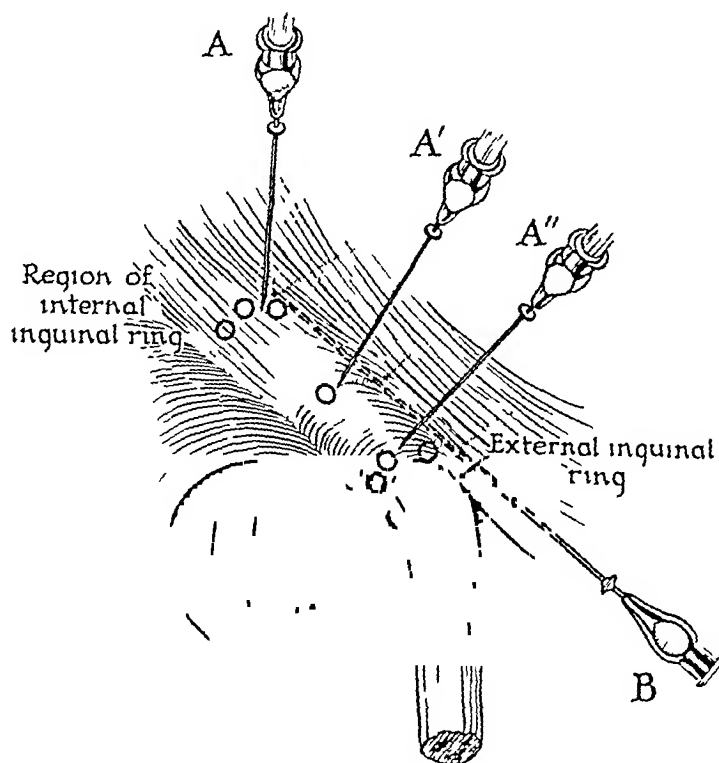


FIG 6—Various points of injection along the inguinal canal (needle A). The solution should always be deposited below and not superficial to the fascia of the external oblique muscle. Several points should be injected at the external ring. The needle point should be within the external ring so that none of the solution infiltrates into the subcutaneous fat. When this happens, a hard nodule will form. The needle should not go deep enough to injure the cord.

The internal ring can also be injected by introducing a 2½ or 3 in needle (B) through the external ring and passing it upward along the inguinal canal to the region of the internal inguinal ring. After passing the external ring it is carried upward to about 1½ to 1¾ in. There is, however, more danger of injuring the cord with this technic.

ring. Only half the usual amount should be used when treating in this manner. About one treatment with the phenol-thuja mixture to three or four of the Proliferol seems to give better results than either one alone. At the present time it appears as though our best results follow the use of a combination of the phenol-thuja mixture with Proliferol. For this two drops of the phenol-thuja mixture are added to 1 cc of Proliferol. Ricinolate preparations very often cause severe after-pain or cramps and occasionally result in shock.

An ordinary 5 cc Luer syringe, with a 2 in No. 22 gauge needle, is very satisfactory for the injection. An alcohol sponge for preparing the skin is sufficient as demonstrated by the few abscesses that have developed

Before injection of the irritating solution, 2 cc of 2 per cent novocain solution without adrenalin are injected at the site to be treated. The needle is left in place and in a minute the solution is injected into the anesthetized area. Aspiration should always be attempted before injecting any solution. Where the ricinoleate preparations or phenol-thuja mixture are used, it is not necessary to use any anesthetic. Up to 5 cc of Proliferol can be used at a treatment. Up to 3 cc of the ricinoleate solutions can be given at one treatment. Figures 8 and 9 show methods of injection of femoral and umbilical herniae.

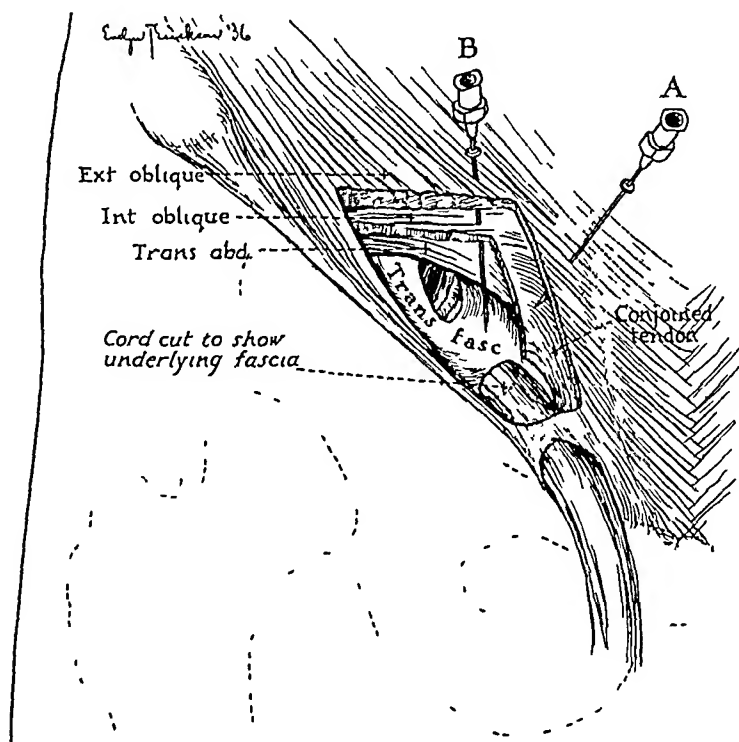


FIG 7—The technic for the injection of Hesselbach's triangle. In the case of direct herniae the needle (A) can be slid along the outer edge of the rectus abdominis muscle or can be inserted (B) into the triangle lateral to the rectus abdominis from above. In this manner the triangle can be injected without injury to the cord. The needle should be introduced until it meets the resistance of the transversalis fascia in the conjoint tendon.

**COMPLICATIONS**—A number of complications have been mentioned: swelling of the cord, hydrocele, epididymitis, sepsis, strangulation, sterility, abscess, and peritonitis. Occasionally there will be a systemic reaction following the use of tannic acid preparations. This has not resulted since the use of synthetic tannic acid in alcohol was discontinued. With the ricinoleate preparations there is very often marked pain which may become general over the entire abdomen. This may be so severe as to simulate shock. Swelling of the cord has been noted in a few cases and this has usually appeared toward the end of the treatments, but has caused no serious disability. Only rarely can fluid be aspirated from an hydrocele of the cord. Where an hydrocele of the cord has resulted it will usually be absorbed and cause no serious trouble. Occasionally a case will show an anesthesia or hyperesthesia after treatment.

This will usually be confined to an area in the lower inguinal region, or the anterior surface of the thigh. One case had a temporary partial paralysis of the femoral nerve. He complained of weakness of the leg on standing, and the tendency of the leg to draw backward and upward. When seen one hour later this had completely disappeared, and he was working at his usual occupation in about three or four hours. Phenol-thuja solution was used in this case. There was, however, no permanent anesthesia, epicritic or protopathic. From correspondence with other physicians I have learned of three cases with similar reactions. In one of these there occurred a slight atrophy of the quadriceps femoris group of muscles. One case had an hyperesthesia of the

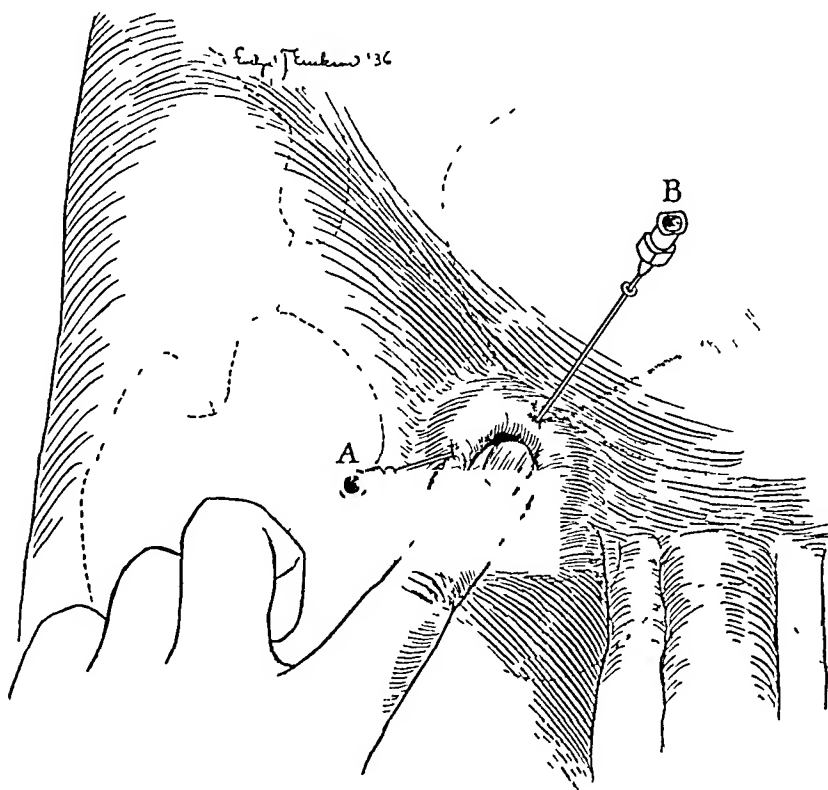


FIG 8—Femoral hernia can be injected very easily by placing the tip of the finger in the femoral canal and then injecting the solution immediately below the tip of the finger. Not over two or three drops of phenol-thuja solution or 2 cc of other solutions should be injected at one time in femoral herniae. As a rule, not over three or four injections are necessary to obliterate a femoral hernia.

thigh which lasted four weeks before clearing up completely. There have been two cases that developed abscesses and a slough, neither of which proved serious as the slough was entirely in the subcutaneous tissues. Two additional cases were seen in consultation that had been injected with phenol-thuja solution. Immediately after injection there was severe pain near the periumbilical point on the injected side. Discoloration of the skin and a slough resulted in these cases. This probably resulted from the injection of the mixture into the deep epigastric artery, causing complete obliteration of the terminal distribution of the epigastric artery so that the collateral anastomoses could not be reestablished before necrosis began. If the precaution had been

observed of aspirating before injection this complication could have been obviated. There have been no cases of peritonitis in our own series of cases. One of our cases which was injected with Proliferol had very severe abdominal pain after treatment. He was operated upon immediately but showed no evidence of peritonitis or infection of any kind. The hernia was repaired and the postoperative course was uneventful. Occasionally a case will have

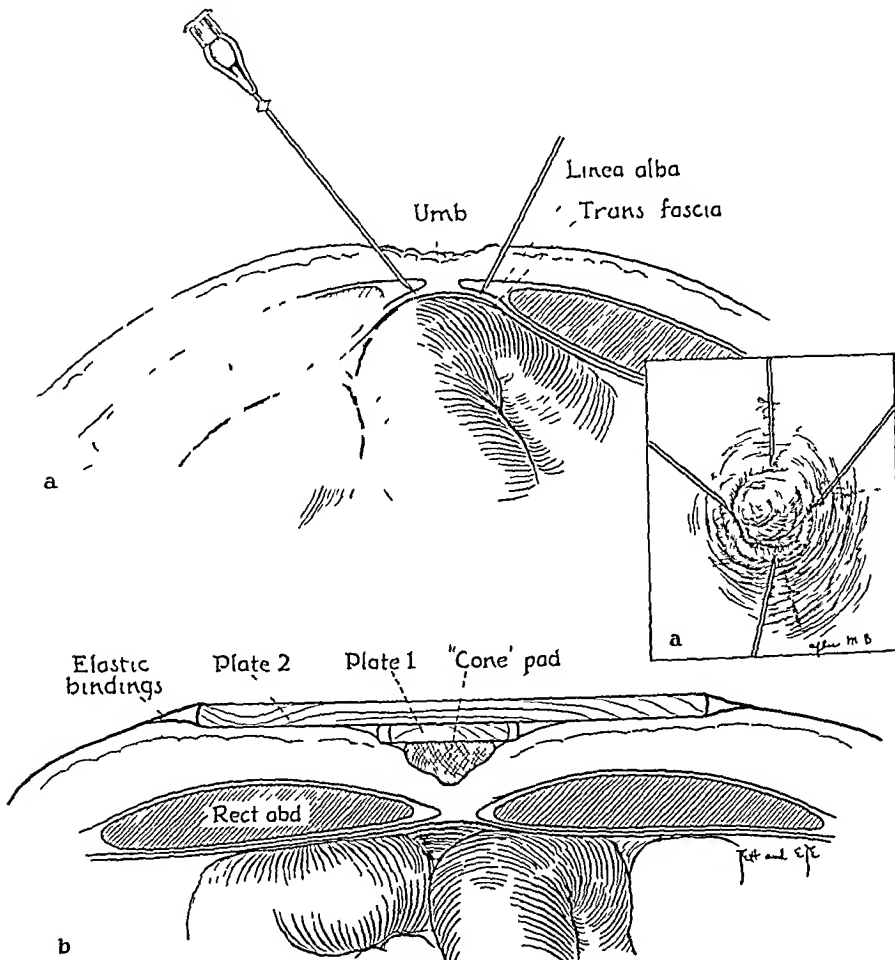


FIG 9—(a) Method of injection of umbilical herniae. Novocain should first be used as injected in inguinal herniae, only in a small quantity. Not over 1 to 1½ cc of Proliferol should be injected at a time at various sides of the hernia. The needle should reach down to the edge of the fascia. (a') Various points around the hernia should be infiltrated. (b) Cross section of an umbilical pad, showing cone shaped truss pad which fits into the hernial opening and then two plates which support this. After this pad is put in place, it is held by an elastic bandage wrapped around the abdomen several times.

pain as soon as the injection is commenced, regardless of whether it is below the fascia or in the deeper structures. If this happens the injection should be stopped. Such pain has proven temporary and has never continued for any great length of time. A few cases have had general abdominal pain, but without untoward effect. In the main such pain has lasted but a few minutes. In one instance, however, it continued for a day and it is my impression that the injection fluid entered the peritoneal cavity in this case. One case treated elsewhere died at the University Hospital. Sixteen minims of phenol-thuya

mixture had been injected into the peritoneal cavity with perforation of the ilium, resulting in peritonitis and death

The course in cases treated after injection shows an induration in the region of the injection. This is usually tender to pressure on the day following treatment. Usually after two to four treatments there is sufficient exudate or plastic tissue formation to prevent protrusion of the viscera even without the truss. There have been a few cases where a swelling of the cord resulted, but this usually subsided in a few weeks. Hot packs relieve the pain when present. The external ring shrinks in size and the fascia can be felt to thicken, so that at the end of a few weeks the external ring will not admit the tip of the index finger. This usually begins after two injections at the external ring. Practically all patients mention the great relief obtained as soon as they are fitted with a truss and have had two or three treatments. There is less soreness and pain from Proliferol than from either the phenol-thuja or Mayer's solutions, and this, used in conjunction with the phenol-thuja solution, seems to give better and quicker results than any of the solutions alone.

**OBJECTIONS**—The objections which have been mentioned concerning this type of treatment should be considered. Paraffin injections can be dismissed without further discussion, for it is a well established fact that the method resulted in very few permanent cures. It caused irritation from the foreign body present, and required surgical interference for its removal and the closure of the hernia. The fact that it has been used only by quacks is not a good argument, for it is not so many years ago that reputable medical men were severely criticized for the injection of hemorrhoids or varicose veins, and today they are both accepted and recognized. The so called Timmerman treatment by alcohol should be discarded on account of the large number of injections required, and the fact that numerous complications have resulted. The fact that irritating solutions cause discomfort and pain sufficient to cause patients to be incapacitated has not been substantiated. It is true that some cases will have a greater reaction than others, but very few cases suffer sufficiently to incapacitate them from heavy work. Another objection is the fact that the truss must be worn for a long period of time. A properly fitting truss is of no more inconvenience than a well fitting glove, after the first few days. I think it can be safely stated that 80 per cent of all hernia cases are wearing trusses at the present time, and that only one out of ten trusses holds the hernia properly reduced. It has been stated that this is a blind and not a rational procedure. To that I may reply that there is a definite technic, and unless this is learned great harm may result. This cannot be too strongly emphasized.

**ADVANTAGES**—There are several advantages in this form of treatment, the principal one being that it is ambulatory—the patient continues working, is not confined to the hospital for a period of two weeks and is not incapacitated for another period of four to eight weeks. There is no question but

that the economic issue is of greatest importance at the present time. To illustrate this, one case may be cited. It concerned a man 67 years of age, with a large scrotal hernia, suffering from a bronchial asthma and hypertension. He had had two recurrences following surgical repair, and was wearing the fourth ineffectively fitting truss. There was a large ulcer in the groin. This was a case of complete total permanent disability. He was put to bed with the foot of the bed elevated, and was given daily injections for five days. He returned to duty on the seventh day, and has continued at his employment without losing any more time. At the present time he has a very good result, but he has been advised to always wear his truss when he has a bronchial cough.

There is no question but that recurrences of hernia following surgery are much greater than statistics show, for herniae will recur, or a new hernia develop, as late as 15 to 18 years after the operation. It is most difficult to obtain satisfactory information concerning the actual percentage of recurrences. The incidence of recurrence following the injection treatment is really higher than stated by most men. A number of surgical cases that began to show weakening and beginning recurrence were fitted with a truss and treated by injection. In this manner recurrence of the hernia may be prevented. I believe that the recurrence of hernia following operation can be largely done away with, provided that patients are fitted with a truss and compelled to wear it for a period of time after operation. The case should be supplemented by injection treatment if there is any suggestion of recurrence.

**DISADVANTAGES**—Among the disadvantages of this form of treatment should be mentioned the prolonged period of treatment, the wearing of a truss, inability to cure a small percentage of herniae, and the reaction which is manifested by pain and swelling which a few cases develop. However, where a truss fits properly it is not a discomfort. Very rarely does a case have such a severe reaction as to incapacitate him. There will be an occasional case which cannot be successfully treated, but this does not form any contra-indication as far as later surgery is concerned.

These cases are not discharged as cured until they have been observed for at least one to two years. They are kept under treatment until a good firm induration is established throughout the inguinal canal, and there is no impulse on coughing or straining. Patients should not be made to cough or strain before at least six injections have been given, or before it is felt that the hernia is closed. A good method of determining whether or not the hernia is completely closed is to have the patient stand and, after straining, massage the inguinal region to determine whether any feeling of weakness or "give" can be felt.

**INSTRUCTIONS TO PATIENTS**—The following instructions are given to every case concerning the essentials of treatment.

(1) The truss should be worn next to the body, removed in bed and put on in bed, the truss is to be worn night and day for a month after treatment is finished.

(2) If the truss does not stay in position, a strap fastened in front and back will hold it in place

(3) The pressure of the pad should produce a depression in the skin

(4) If the hernia becomes painful, or if the truss causes distress, report to the clinic for examination

(5) The hernia must be held back at all times by the truss. You will be able to continue your regular occupation, but if you do any heavy lifting, be certain that the truss is in proper position

(6) The usual number of injections varies between 8 and 16

(7) The truss should be worn six months after the last injection. At the end of this period return for check up

(8) It is also well that you report for examination every two months for about two years after the final check up

(9) If at any time a recurrence develops, we would appreciate it if you would return for examination or notify us to that effect

#### CONCLUSIONS

(1) The ambulant treatment of hernia is a safe and effective method of treating certain types of herniae, if proper technic is used, but there is danger of complications if essentials are not strictly adhered to

(2) It demands the cooperation of the patient in the proper wearing of the truss

(3) It brings the mechanical treatment of herniae from the hands of those who know little or nothing of diagnosis, pathology, and anatomy, into the hands of physicians who should know this form of treatment

(4) Knowledge of the fitting of trusses and the technic of the injection is absolutely essential

(5) Recurrence of hernia can be very nearly done away with by the combined surgical and injection treatment

(6) Patients who are incapacitated and have definite surgical contraindications can be so greatly relieved that they may pursue a gainful occupation, and in many cases a cure can be effected. Complications as mentioned have not been substantiated to date by clinical cases

#### REFERENCES

<sup>1</sup> Bigelman, Leo. Nonsurgical Treatment of Hernia. Med Rec, August 21, 1935

<sup>2</sup> Bratrud, Arthur F. Ambulant Treatment of Hernia. Lancet, 53, 673, 1933

———. The Ambulant Treatment of Hernia. Minnesota Med, July, 1935

———. The Ambulant Treatment of Hernia. Iowa Med Jour, August, 1935

———. The Ambulant Treatment of Hernia. Industrial Med, September, 1935

<sup>3</sup> Fowler, Samuel W. Experience with the Injection Treatment of Hernia. Med Rec, February 20, 1935

<sup>4</sup> Goldhahn, Richard. Ueber schwere Schädigungen nach Bruchbehandlung mittels Alkoholinjektionen. Klin Wchnschr, 9, 1447, 1968, 1969. 1930, 10, 72. 1931

<sup>5</sup> Gray St Geo B Del. Injection Treatment of Inguinal Hernia. Brit Med Jour, 2, 2, 1932

- <sup>6</sup> Hall, James S K   Eradication of Hernia by Injections ' Experiments and Clinical Investigation with the Method Which Was Originated by Dr E P Mestre of Barcelona Preliminary Report Med Jour and Rec, 130, 61, 1929
- <sup>7</sup> Heaton, George   New Treatment of Hernia Boston Med and Surg Jour, 26, 421, 1843 The Cure of Rupture, Reducible and Irreducible J H Davenport, Editor Houghton, 1877
- <sup>8</sup> Jacobi, H       Schwere Schädigung nach Bruchbehandlung mittels Alkoholinjektion Bemerkungen zu der Arbeit von R. Goldhahan Klin Wchnschr, 10, 71, January 10, 1931
- <sup>9</sup> Jameson, F Slater, and Cantala, Jr   Relief of Inguinal Hernia Without Operation Med Jour and Rec, 131, 87, 1930
- <sup>10</sup> Lannelongue, O M   Un tour du monde, Librairie Larousse, 296-297, Paris, 1909
- <sup>11</sup> Mayer, Ignatz   Treatment of Hernia by Subcutaneous Injections Med Jour and Rec, 125, 528, 1927
- Corrective Treatment of Hernia Med Jour and Rec, 135, 275, 1932
- <sup>12</sup> Mestre, Pina   Las Inyecciones Proliferantes Obturados en las hernias Abstract in J A M A (edicion español), 18, 186, 1927 (Reported by Mayer)
- <sup>13</sup> McMillan, W M   Injection Treatment of Reducible Hernia J A M A, May 23, 1936
- <sup>14</sup> Quillin, Lawrence, J   Injection Treatment of Reducible Hernia Internat Jour Med and Surg, 47, 394, 1934
- <sup>15</sup> Rice, Carl O   The Rationale of the Injection Treatment of Hernia Minnesota Med, September, 1935
- <sup>16</sup> Slobe, Frederick W   The Injection Treatment of Hernia Industrial Med, May, 1935
- <sup>17</sup> Velpeau, A A L M   New Elements of Operative Surgery Translated by P S Townsend, 3, 554, New York Wood, 1847
- <sup>18</sup> Velpeau, M   The Anatomy and Surgical Treatment of Hernia New York, 272, D Appleton & Co, 1892
- <sup>19</sup> Warren, J H   Hernia, Strangulated and Reducible Springfield, Illinois, Chas N Thomas, 1881
- <sup>20</sup> White, Alfred S, and Harris, Franklin I   The Injection Treatment of Hernia Surg, Gynec, and Obstet, August, 1936
- <sup>21</sup> Wolfe, Ralph   Injection Treatment of Hernia Med Jour and Rec, 133, 242, 1931
- <sup>22</sup> Wollermann   Die Timmermannsche Injektionsbehandlung der Hernien, Aerztl Rundschau, 39, 328, 1929

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## AN EVALUATION OF THE RESULTS OF THE INJECTION TREATMENT OF INGUINAL HERNIA

A REVIEW OF THE EMPLOYMENT OF THIS METHOD AT THE UNIVERSITY  
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HERNIA has been defined as a protrusion of some organ or tissue from its natural situation through an accidental or natural opening in the wall of

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the cavity in which it is contained, but the mere presence of a perforation or an aperture in the cavity wall, either accidental or natural, through which some organ or tissue may protrude at a later time, is not a hernia. The reduction or elimination of the hernia is effected by the application of a truss. Technically, the hernia is not injected. The treatment is directed to the opening, aperture, canal or rings through which the hernia protrudes. By repeated injections of irritating solutions into the hernial canal, fibrous connective tissue is produced. The hernia is retained by the truss until this tissue reaches its maximum toughness and tensile strength. This treatment is in reality, first, the mechanical or truss treatment of hernia and if this is successful, the injection therapy follows.

**GENERAL STATISTICAL ANALYSIS**—In the five year period from August 1, 1931, to August 1, 1936, approximately 700 patients have been admitted to the Hernia Clinic of the University of Minnesota Surgical Dispensary. This report concerns 554 patients admitted to the clinic before 1936. Of this number 300 cases had had a sufficient number of injections (at least six) for statistical study. In this group 230 patients returned to the clinic for examination and 70 patients replied by letter or were examined by other physicians. Six months' time had elapsed from the date of the last injection before examination in all cases and in the majority from one to three and one-half years had elapsed. There were 77 patients fitted with a truss who received no injections, 54 patients received three injections or less, 36 patients had irreducible herniae or preferred surgery, 87 patients could not be traced. The age range of patients was from two months to 84 years, average age of this group was 47.5 years (Table I). About 40 per cent of the patients reside in the Twin Cities and have occupations typical of any outpatient dispensary group. The remaining 60 per cent are from the more rural sections of the state. Their predominant occupation is farming.

TABLE I

	No of Cases	No of Injec- tions	Aver- age Age	Young- est	Old- est	Over 50 Years	Over 60 Years
Indirect—Cured	177	16.2	50.9	17 mos	80 yrs	34 cases	41 cases
Indirect—Not cured	37	9.6	44.9	5 yrs	80 yrs	11 cases	8 cases
Scrotal—Cured	38	16.2	36.5	2 mos	70 yrs	5 cases	4 cases
Scrotal—Not cured	5	16.8	52.8	32 yrs	65 yrs	1 case	2 cases
Direct—Cured	12	20.1	61.0	46 yrs	75 yrs	4 cases	6 cases
Direct—Not cured	3	12.0	67.3	56 yrs	73 yrs	1 case	2 cases
Recurrent—Cured	23	15.7	52.8	16 yrs	84 yrs	5 cases	9 cases
Recurrent—Not cured	5	19.4	53.4	45 yrs	61 yrs	3 cases	1 case

Percentage patients cured—83 per cent

Percentage patients not cured—17 per cent

**DISCUSSION OF RESULTS**—The method used in the treatment of a hernia by injection differs radically from the surgical treatment. Table I shows the number of injections for both cured and noncured cases. Cured cases are

those in which we could find no evidence of viscera in the inguinal canal or any abnormal bulging. The gradual elimination of the hernial defect by the injection therapy requires a large number of injections and from the above table some definite conclusions, as to the number of injections required for a given type of hernia, can be drawn. The cured cases in the indirect inguinal group had almost twice as many injections as the failures. In the scrotal type of hernia the failures occurred in the older age group. The cured direct herniae required more injections than the indirect and those listed as failures in the direct group were patients over 50 years of age. It is more difficult to cure herniae with this therapy in aged than in young individuals. In the recurrent group only 28 of our 47 cases (recurrent herniae accounted for 8 per cent of admissions) have been traced. One patient had eight operations on each side, another, three, and nine, two operations. The majority of these cases, if of recent origin, responded quickly, others with large defects in the abdominal wall required a greater number of injections. Sometimes the patients have become discouraged, but a decrease in the size of the hernia occurred in all cases. The injection in the recurrent type of hernia should be made at the internal ring or at the lower angle of the inguinal canal just above the pubic bone. Injections are given every other day until the parts become so swollen that an interval of rest is indicated. When the swelling has subsided and bulging or weakness is still present, injections should be continued.

In the first year of the clinic no scrotal herniae were injected, but, as the clinic grew, an increasing number of patients who had had scrotal herniae for many years presented themselves for treatment. None of these cases was injected, however, until we were satisfied that the truss held the herniae reduced under any physical strain. In many cases a month and in one case three months elapsed before treatment was begun. Older writers on hernia spoke of these scrotal herniae as having lost their right of domicile in the abdomen. Until the viscus resumes its normal habitat in the abdomen it is useless to start injections. The presence of a large sac (which in this form of therapy is not removed) may mean a slight recurrence of the hernia in six months or a year. Our patients are instructed to present themselves every three or four months up to two years after the first series of injections. In practically every case where a recurrence developed, only a small number of injections, usually three or four, were necessary to close this defect. Whether our failures are recurrent herniae or insufficiently injected cases is sometimes difficult to answer. Many of our early cases recurred, but they had had a minimum number of injections. The patients insisted on more injections because the recurrence was smaller than the original hernia. Usually a case where the hernia recurs in a short time after the removal of the truss can be classified as one insufficiently injected but, after a lapse of several months, as a recurrence. Four cases required more than 40 injections, one case required 52 injections spread over a two year period. The prolonged treatment was due to the failure of the first truss to completely retain the hernia. A large stock of trusses is

kept on hand because the patients are fitted in the clinic. For a while the patients were allowed to retain the truss they were wearing, but many of these cases did not respond well to treatment and time can be saved if the patient is fitted with a new spring truss. A correct pad for each patient is just as important as the truss itself. The obese, overweight person required a larger and thicker pad than the average individual. The oversized truss has given us better results than the one fitted exactly to the patient's measurements.

**RESULTS WITH REFERENCE TO VARIOUS AGE GROUPS**—A group of 15 children under 13 years of age were injected, only two cases (girls 7 and 11) reported by letter that their herniae were not cured after six injections. The other 13 cases were examined at the clinic. In this group were two infants (2 months and 17 months respectively). Both of these cases had had scrotal herniae since birth and examination after two years revealed a complete closure of the inguinal canal. The treatment of infants and children by injection is disagreeable due to the psychic element. The majority of our failures were in patients past 50 years of age. The obese, overweight individual is a poor subject for injection therapy. Herniae present for a great many years, with resulting damage to the abdominal wall, do not respond so quickly to this form of therapy as those of recent origin.

**TREATMENT OF HERNIA IN PATIENTS WHERE SURGERY IS CONTRAINDICATED**—Two hospital cases ill with tuberculosis and enterocolitis respectively, had scrotal herniae. The descent of the herniae by coughing and bowel movements caused them intense pain. Injections into the inguinal canal blocked the descent of the herniae.

**TREATMENT OF MISCELLANEOUS GROUPS** (three epigastric, seven umbilical, and five femoral herniae)—The epigastric herniae can be treated if the defect is small. In a femoral hernia the pad of the truss rests on the thigh and in this position is easily displaced by muscular movement. Success of treatment depends upon complete reduction of the hernia by the truss. Injection should be made cautiously due to the close proximity of the femoral canal to the femoral vessels. The treatment of small umbilical herniae has been satisfactory.

**COMPLICATIONS**—The most frequent complication is the swelling of the spermatic cord. Five patients from this group of 700 patients were admitted to the University Hospital for other reasons, however:

- (1) Patient, age 76, had a large scrotal hernia which had been present for 30 years. The hernia strangulated following the fitting of a truss. He had no injection. Operation. Recovery.
- (2) Patient developed a severe pain in back and side following injection. A slough (size of a dollar) opposite umbilicus from injection of deep epigastric artery. Slough healed in three weeks.
- (3) Patient had symptoms of local peritonitis (nausea and vomiting) following injection for recurrent hernia. Operation. Small area of local peritonitis found. Repair of hernia. No drainage. Uneventful recovery.

- (4) Patient with abscess following injection for a recurrent hernia after appendectomy Drained three weeks Recovered
- (5) Patient with large scrotal hernia Injection made into the sac of the hernia Large swelling of scrotum Patient in hospital five days Complete recovery

Two other patients seen outside of the University Outpatient Clinic in consultation presented the appended complications

- (1) A patient injected for hernia developed, three days later, an embolus or thrombus in the anterior tibial artery on the same side He lost one toe, but collateral circulation had been reestablished The patient had previously complained of cramps in the legs and suffered from generalized arteriosclerosis
- (2) Patient developed an abscess following the accidental injection of one cubic centimeter of Proliferol into a blood vessel of the spermatic cord An abscess was about two weeks in developing Drainage Uneventful recovery

There has been no mortality either directly or indirectly in this group of 700 cases as a result of injection therapy A patient entered the University Hospital with peritonitis following injection for a hernia by another physician This patient died in the hospital Autopsy revealed a perforation of the ileum The absence or presence of varicocele, spermatocele, hydrocele, swelling of epididymis or atrophy of the testicle should be noted before treatment is begun Distinct atrophy of the testicle was found in 20 of the 300 cases Mumps and trauma were given as likely etiologic factors Two cases were congenital Atrophy of the testicle has not occurred as a result of injections for hernia It is almost a truism, found in every text-book on surgery, that the truss is the most important cause of strangulated hernia and we expected this as a frequent complication Only two cases of strangulation have occurred, one listed above (1) and the other a woman whose hernia strangulated after 15 injections

#### EVALUATION OF THE INJECTION METHOD

DISADVANTAGES—(1) The long period of time required to obtain a wholly satisfactory result

(2) Uncertainty as to the number of injections each individual case requires

(3) Inability of some patients to keep the hernia reduced by the truss (a scrotal hernia in a young farmer did not respond to injection treatment It was the patient's habit to remove his truss the second or third day after injections because of soreness After one treatment he lifted 150-pound cakes of ice all day without his truss)

(4) Sickness, accidents, lack of funds for transportation and change of residence and occupation frequently cause either prolonged or inadequate treatment

## INJECTION TREATMENT OF HERNIA

(5) Too often the patient makes his own diagnosis as to the cure of his hernia (the swelling produced by the injection blocks the hernia. He then believes a cure has been obtained. When the edema and swelling subside he may find his hernia recurring. Actually his hernia was not cured and what we observe is a natural process, the absorption of the products of inflammation. Frequent examinations are necessary before we can be sure sufficient injections have been given)

ADVANTAGES —(1) Patient is able to continue his regular occupation

(2) No serious complications have resulted from the injection treatment

(3) Patients suffering from constitutional diseases, where surgery is contraindicated, can receive treatment

(4) In the recurrent herniae following operation, if the defect is not too large, this method offers the patient a way out of his difficulty if he does not wish another operation

(5) Applicability to patients of advanced age (while difficulties have been experienced in closing herniae in the older age group that have been present many years, some excellent results have been obtained in aged patients)

### CONCLUSIONS

The merits of hernioplasty versus the injection treatment is a question naturally asked. In some respects the problem is identical with the question of medical treatment versus surgery in the treatment of peptic ulcer. The medical treatment may require several months, the surgical often one operation. The impossibility of standardizing this method with respect to the number of injections and length of time treatment is required and also its ambulatory nature (success depending on the patient's cooperation) have been factors in many poor results. *Too much emphasis has been placed on the injected solution and not enough on a proper fitting of the truss.* The injection therapy has a place in the cure of hernia and instead of condemning it as quackery, surgeons should add it to their armamentarium in the treatment of hernia. The small hernia in the young individual offers the *ideal* case for treatment by this method.

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## THE INJECTION TREATMENT OF HERNIA

### AN EVALUATION OF THE TECHNIC AND RESULTS

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THE technic which is employed at the Minneapolis General Hospital for the cure of hernia, by the injection method, carries out the same principles as those which are employed in the surgical treatment of this condition.

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the closure of the defect through which the hernia passes and the occlusion of the hernial sac

Whether or not these principles are accomplished by one method or another should make no essential difference as long as the risk of doing it is not increased and the end-results are satisfactory. Likewise the solution which is employed to cause the irritation, and thereby produce fibrous tissue hyperplasia, is of secondary importance as long as the solution does not produce too extensive damage to the tissues. There are some side-effects produced from the injection of some of the solutions, which have been employed for this purpose, which, though they may not be harmful, seem undesirable. Among these are excessive exudative reaction in the tissues following injection, pain produced from the injection and the danger of systemic reaction from an inadvertent intraperitoneal or intravenous injection.

There are a number of solutions which have been recommended for the injection treatment of hernia. These solutions are essentially of two different kinds. Those containing an acid in alcoholic solution or caustic salts (the principle ones of which are tannic acid, phenol and zinc sulphate) and those consisting of a mild soap solution. Most all of the solutions produce the desired irritation and the development of fibrous tissue but some of these present undesirable features because of their excessive irritating qualities, pain produced from their injection or danger from systemic reaction if inadvertently injected into the blood stream or peritoneal cavity. This is particularly true of the acid-alcohol solutions. It appears, from the evidence obtained at the Hernia Clinic of the Minneapolis General Hospital, that the mild soap solution which we have employed possesses advantages which have not been obtained from the use of the acid-alcohol mixtures.

**FACTORS IN DETERMINING THE SELECTION OF CASES**—The selection of suitable cases for the injection is a large factor in the determination of the end-results. It is not presumed that every hernia can be cured by the injection method. On the other hand, an unwise selection of cases will materially decrease the percentage of cures and thereby detract from the true value of the method. Experience has taught the value of judicious selection. In order to be suitable for the injection treatment the hernia must be first reducible and capable of being retained with a properly fitting truss.

As the external ring is the only measurable criterion by which the suitable case can be selected, an effort has been made to determine, from this physical finding, those cases which are satisfactory subjects. If the external ring measures more than 3 cm. in diameter, it has been found that a cure is difficult to obtain. For that reason we have arbitrarily chosen to exclude from the injection treatment, individuals whose external ring is larger than 3 cm. in diameter.

Excessive obesity is also a contraindication for the injection treatment. It may be difficult to define at what stage a person may be considered excessively obese but for our purposes if the obesity is sufficient to make examina-

tion and identification of the inguinal anatomy difficult it is then sufficient to make a cure by the injection method unsatisfactory

Individuals who are required to strain at stool or while urinating, those with a chronic uncontrollable cough or any other condition which will produce abnormally increased intra-abdominal pressure are not accepted for the treatment until these factors have been controlled

Age is not a factor. The young as well as the aged can be satisfactorily treated and cured. Syphilis, diabetes, hemophilia and a number of other diseases have been considered contraindications but these do not constitute absolute contraindications and may be left to the judgment of the physician

*Technic*—The accompanying drawings illustrate clearly the mechanics of depositing the solution in the proper position. The details of the technic have been more fully dealt with by Dr. Bistrud.

**DIRECT INGUINAL HERNIA**—In cases of direct inguinal hernia the plane of the weakened transversalis fascia, overlying the lower half of Hesselbach's triangle, is infiltrated with the irritating solution by placing the injections successively, at two or three day intervals, in the areas indicated by the numerals 1 to 10 (Fig. 1). This accomplishes the purpose of closing the defect through which a direct hernia passes, just as is done at the surgical operation when suturing the conjoined tendon to Poupart's ligament, under the cord. In this type of hernia the sac drops back into the peritoneal cavity and is, presumably, eventually contracted and obliterated by the scar tissue which is formed above it in the plane of the transversalis fascia.

Twelve injections have been found to be the average number required for the direct inguinal hernia.

**INDIRECT INGUINAL HERNIA**—In cases of indirect inguinal hernia the internal ring is first constricted by injections placed circumferentially around the cord at the point where it makes its exit from the abdominal cavity, as indicated in Fig. 2 by numerals 1, 2, and 3. This constriction of the internal ring accomplishes the same principle as is accomplished at the surgical operation when the internal ring is made narrower with the aid of a Coley's stitch. Subsequent injections are placed circumferentially around the cord, in the inguinal canal, as indicated in Fig. 2 by the numerals 4 to 10. These tend to constrict the inguinal canal just as is effected at the surgical operation when the fascia of the external oblique is sutured over the cord. A few additional injections are placed in the plane of the transversalis fascia just as is done for the direct inguinal hernia (Fig. 1). These latter strengthen the floor of the inguinal canal and are comparable to suturing, at operation, the conjoined tendon or one of the leaves of the external oblique fascia to Poupart's ligament, under the cord. It is important to place a few of these latter injections at the lower angle of Hesselbach's triangle, near the pubic tubercle, in order to reinforce this area, as is so often emphasized at the surgical operation when the young surgeon is taught to catch the first stitch directly into the pubic tubercle and fasten it to the apposing end of the ilio-inguinal ligament.

Those injections which are placed superficial to the cord but under the

fascia of the external oblique muscle (this being the most superficial position of the hernial sac) cause the inflammatory reaction to extend into the hernial sac and thereby occlude it as its two apposing surfaces become adherent to one another with newly formed fibrous tissue. This contention has been positively demonstrated in two cases which were pronounced cured of their hernia and who were subsequently explored during the performance of an incidental appendectomy through a low transverse-oblique incision.<sup>9</sup> In addition, proof has been afforded from the observation of several cases in which an hydrocele corresponded in position to the previous location of the hernial sac. The hydrocele fluid could not be forced back into the peritoneal cavity, indicating

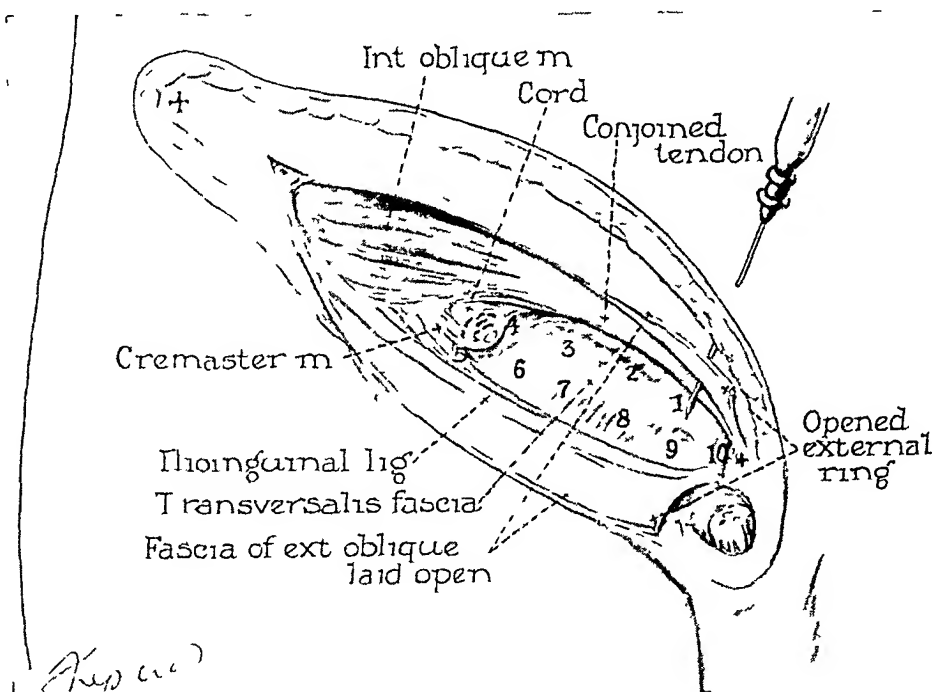


FIG 1.—Method of injecting a direct inguinal hernia. The injections are made at the sites indicated by the numerals 1 to 10. These are in the plane of the transversalis fascia, lying below the level of the spermatic cord.

that the neck of the hernial sac had been occluded. These hydroceles have all been aspirated (the diagnosis thereby confirmed) and a small quantity of the irritating solution injected into their lumen, eventually resulting in their complete and permanent eradication.

In both the direct and indirect inguinal hernia the external ring is made smaller by injections placed around the margin of the external ring, in the plane of the fascia of the external oblique (Fig 3).

The average number of injections for the cure of indirect inguinal hernia has been found to be 10. Some cases have been cured with fewer injections, whereas others have required as many as 20 to 30 injections. These latter are, no doubt, some of the cases which did not receive the injections in the proper position or were patients in whom it would have been better to have recommended surgical operation.

GENERAL CONSIDERATIONS AND PRECAUTIONS—The approach to the in-



## INJECTION TREATMENT OF HERNIA

ginal region is made from above downward, with the needle held at an angle of  $40^\circ$  with the skin of the abdomen. This approach, we feel, avoids the danger of entering the peritoneal cavity, as at this location the peritoneal cavity slopes away from the surface plane of the abdominal wall. There are certain definite symptoms produced if the needle encroaches upon the peritoneum or the spermatic cord. If the peritoneum is punctured, or touched with the needle point, the patient experiences pain throughout the lower part of the abdomen and reflexly tenses the lower abdominal muscles with a quick sudden jerk. If the injection is continued and the solution deposited into the peritoneum the patient will experience a shock-like reaction, with cold sweat,

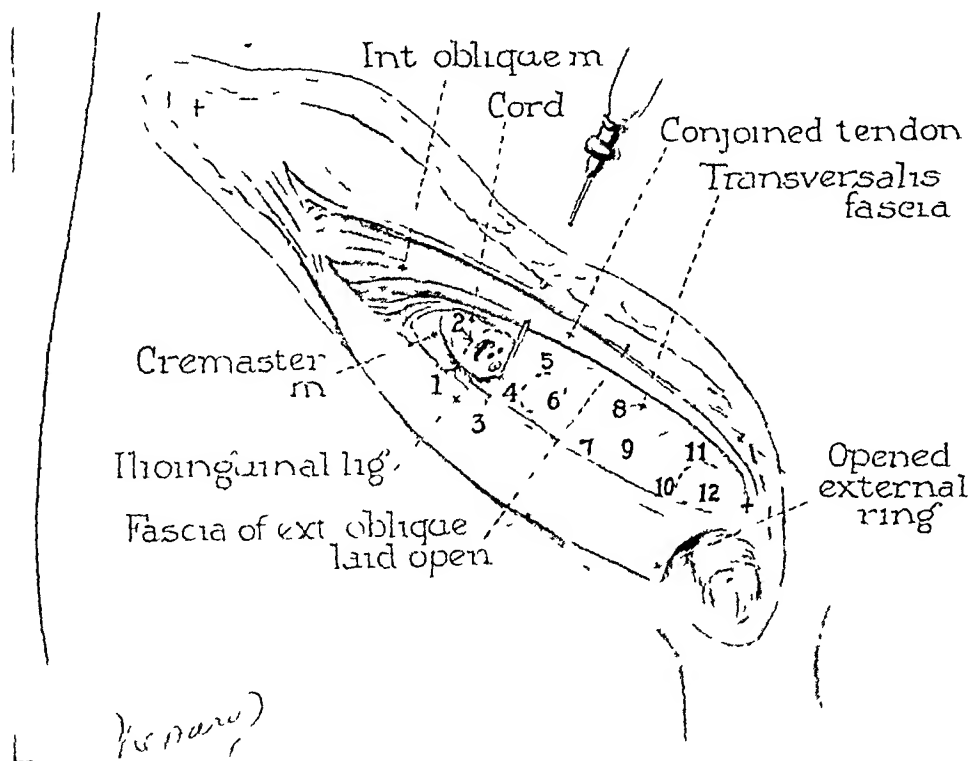


FIG 2—Method of injecting an indirect inguinal hernia. The injections are made circumferentially around the cord, as indicated by the numerals 1 to 12. The first three injections are made around the internal ring. Subsequent injections are placed around the spermatic cord. A few additional injections are placed in the plane of the transversalis fascia as indicated in Fig 1, particularly at the sites indicated by numerals 1, 2, 8, 9, and 10. (These drawings are a copy of those which have been previously published in the Southern Surgeon.)

slow pulse, pain and rigidity of the lower abdominal muscles. These symptoms will subside within 20 or 30 minutes and leave no residual effects unless the solution has entered the peritoneal cavity, in which event the symptoms will persist for two or three days, eventually subsiding without harmful effects. This complication requires observation but no surgical intervention unless the bowel appears to have been injured. If the spermatic cord has been punctured the patient will experience pain which radiates into the penis or testicle. If the solution is injected into the cord an induration of the cord will result. If the tannic acid-alcohol solution is injected intravenously, an accident which may occur inadvertently, the patient will experience a shock-like reaction which may rightfully give cause for a great deal of apprehension.

The intravenous injection of the soap solution gives the patient the taste of soap and a tingling sensation of the body from which they recovered within a few minutes

The use of a local anesthetic, preliminary to the injection, has not been considered advisable as it may disguise the signs, as mentioned above, which would otherwise help to avoid a misplaced injection. In using the soap

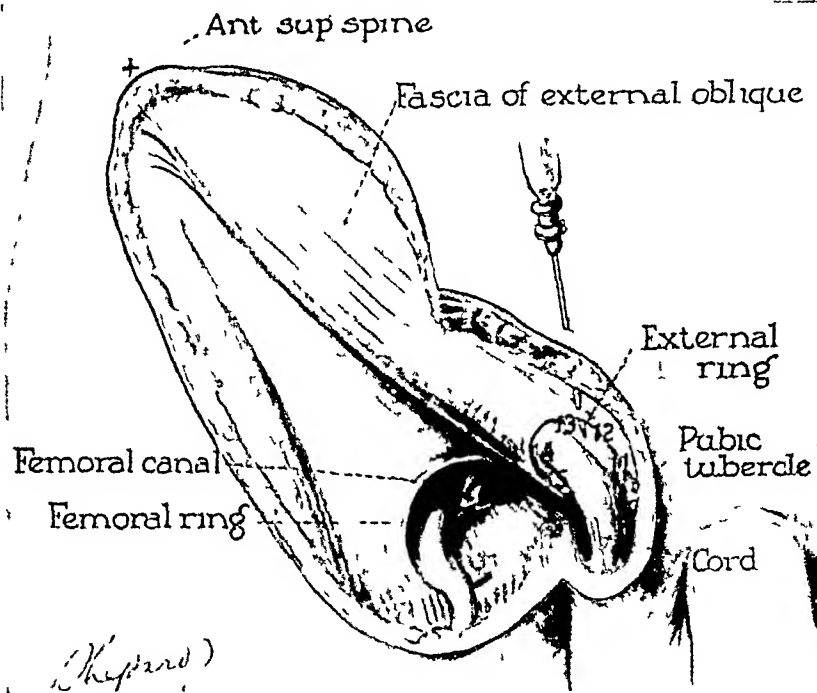


FIG 3—Method of injecting the external ring in both direct and indirect inguinal herniae. Note how the needle passes first through the fascia of the external oblique at the margin of the external ring. This is done so as to get the solution below the external spermatic fascia which passes from the external ring to the spermatic cord at this point.

solution the pain from its injection is so mild that it has never been considered necessary to use a local anesthetic. The tannic acid-alcohol or the zinc sulphate solutions produce so much pain from their injection that it is often difficult to obtain a continued cooperation of the patient unless a local anesthetic is injected a few minutes before.

END-RESULTS—It is of interest to mention the statistics of Wollermann<sup>11</sup> who made a comparison of the injection method with those of the surgical operation (Table I)

TABLE I

	Injection Method	Operative Method
Total number of cases treated	2,949	1,140
Exaggerated reaction and swelling without suppuration	33	130
Prolonged suppuration (deep abscesses, fecal fistula, etc.)	20 (7%)	23
Testicular atrophy	2 (07%)	5
Deaths	1 (04%)	5

The average incidence of cures, as compiled from the figures cited in the literature by Kretzschmar, Mayer,<sup>8</sup> Campos and Subiachs,<sup>4</sup> Jameson, Wolfe,<sup>10</sup> Wyss,<sup>12</sup> Gray,<sup>7</sup> Wolleimann,<sup>11</sup> and Bratrud, totaling 6,550 cases, was 92.6 per cent. The results which we have obtained by questionnaire from 23 doctors revealed 2,216 cases treated and controlled. Eighty-five per cent of these were cured.

A review of the cases at the Minneapolis General Hospital revealed 804 individuals with 1,025 herniae. In 213 of these patients treatment was advised but not given because the patients did not return, 115 patients were referred directly for surgical operation since it was felt that in these patients the hernia would not respond favorably to the injection treatment, 97 of the patients have not received sufficient treatment to be pronounced cured. Some of these have not returned for more treatments and may be cured but have not been included in the known results because we have not been able to obtain a final check up. Cures have been obtained in 379 patients with 445 herniae. Eleven have failed to respond to the treatments. The cure of these cases has been determined by personal follow up observation. No patient has been pronounced cured until the check up examination has revealed "no impulse" for a period of six months after the last treatment and until the patient has been without his truss for at least four months. No deaths have occurred in any of the treated cases.

If only the controlled cases are calculated, 97.6 per cent cures are obtained. Comparing these figures with those which are reported from the surgical treatment, in which statistics ranging from 3 to 30 per cent of recurrences are recorded, it would seem that the injection method offers some advantages. Gibson and Felter,<sup>6</sup> reviewing 1,618 surgical cases, found recurrences in 2.9 per cent. Cattell and Anderson<sup>5</sup> found 6.7 per cent recurrences with unilateral hernia and 18.1 per cent with bilateral herniae. Block<sup>2</sup> made a study of a large series of European cases and found recurrences in 3.5 per cent of the herniae treated by surgery. Andrews and Bissell,<sup>1</sup> from a review of cases treated at the Johns Hopkins Hospital, the Massachusetts General Hospital and the Presbyterian Hospital in New York found that recurrences ranged from 4.1 to 32 per cent with an average of 20 per cent.

**COMPLICATIONS AND SEQUELAE**—Seventy-eight of the 445 cured herniae reported in this paper developed complications, or sequelae, at one time or another during the course of treatment. These complications were as follows: Induration of the cord, 44 cases, superficial ulceration of the skin, as a result of the truss irritation, eight cases, severe pain, suggesting peritoneal irritation, ten cases, chemical peritonitis, two cases, hydrocele of the cord, seven cases, local abscess, two cases, dermatitis, one case. The first three of these complications are of no prognostic significance. The induration of the cord might be compared to the induration of the wound, following surgery. It is rare that anyone ever mentions this as a surgical complication. It adds no difficulties to the healing and does not endanger the life or health of the individual. In fact it probably indicates that the hernial sac is being obliterated by fibrous

tissue formation between its two apposing surfaces. There is histologic evidence to substantiate this contention, as has been shown in a previous publication.<sup>9</sup> Superficial ulceration of the skin, from the truss irritation, would occur whether or not the injections were given. Pain from the injection, too close to the peritoneum, is comparable to the pain which is experienced when the peritoneum is pulled upon at the time of operation if local anesthesia is being used. Therefore, if these three sequelae are excluded from the list of complications so as to make a series which can be compared with the surgical complications, we find the incidence of 4 per cent.

Gibson and Felter reviewed 1,618 surgical operations for hernia. They found complicating factors in 368 of these. Some of these untoward results were evidently not the direct result of the surgical operation. Among these were pneumonia, 34 cases, bronchitis, three cases, cough, 30 cases, infarcts, eight cases, pulmonary tuberculosis, five cases, epididymitis, two cases, varicocele, 23 cases, hydrocele, 74 cases, laryngitis, empyema and influenza, each one case. Among the cases which appear to have followed as a direct result of the surgical operation there were 70 cases of wound infection, 59 hematomata, 21 orchitis, two accidental incisions of the bladder, and one each of accidental cutting of the spermatic cord, a large artery, and the sigmoid colon. If these latter complications are included among the complicating cases so as to make it comparable to our injected cases it is found that the incidence of complications from the operation is 9.7 per cent. This figure represents a little more than twice as great an incidence of complications as that which we have observed from the injection treatment.

#### CONCLUSIONS

With these briefly stated facts, comparing the surgical results and complications with those from the injection method, it appears that the injection method offers a procedure, to the medical profession, which should have a very decided value in the treatment of carefully selected cases of hernia. The technic is not difficult and can be acquired by anyone who wishes to take a little time to study the method. It must be carefully performed, however, in order to obtain the most satisfactory results.

#### REFERENCES

- <sup>1</sup> Andrews, E., and Bissell, A. D. Direct Hernia. A Record of Surgical Failures. Surg., Gynec., and Obstet., 58, 753-761, 1934.
- <sup>2</sup> Block, W. Bericht über eine Sammlung von 20,199 Leistenbruchoperationen (Rezidive). Arch. f. klin. Chir., 175, 607-624, 1933.
- <sup>3</sup> Bratrud, A. F. The Ambulant Treatment of Hernia. Minn. Med., 18, 441-451, 1935.
- <sup>4</sup> Campos and Subirachs. The Treatment of Hernia by the Fibrogenous Method. Informacion Med., 6, 155, 185, 1929.
- <sup>5</sup> Cattell, R. B., and Anderson, C. End Results in the Operative Treatment of Inguinal Hernia. A Report of 150 Cases at the Lahey Clinic. New England Jour. Med., 205, 430-432, 1931.
- <sup>6</sup> Gibson, Chas. L., and Felter, Robert, K. End Results of Inguinal Hernia Operation. ANNALS OF SURGERY, 92, 744-753, 1930.

- <sup>7</sup> Gray, St G B de L Injection Treatment of Inguinal Hernia Brit Med Jour, 2, 12-14, 1932
- <sup>8</sup> Mayer, Ignatz The Treatment of Hernia by Subcutaneous Injection Med Jour and Rec, 125, 528, 596, 672, 1927, 128, 415, 1928, 131, 90, 1930
- <sup>9</sup> Rice, Carl O, and Larson, L M Technique for the Injection Treatment of Hernia Southern Surgeon 5, 227-233, 1936
- The Fate of the Hernial Sac in Hernia Treated by the Injection Method Western Jour Surg, 44, 428-429, 1926
- Rice, Carl O, and Mattson, Hamlin The Histologic Changes in the Tissues of Man and Animal Following the Injection of Irritating Solutions Intended for the Cure of Hernia Illinois State Med Jour, September, 1936
- Rice, Carl O The Rationale of the Injection Treatment of Hernia Minn Med, 18, 623-626, 1935
- <sup>10</sup> Wolfe, Ralph Injection Treatment of Inguinal Hernia Med Jour and Rec, 133, 243-246, 1931
- <sup>11</sup> Wollermann Die Timmermannsche Injektionsmethode in den letzten 25 Jahren Aerzt Rundschau, 39, 283-284, 1929
- <sup>12</sup> Wyss, Franz Die Behandlung der Hernien mit Alkoholinjectionen Schweiz med Wchnschr, 59, 85-89, 1929

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## STERILITY FOLLOWING THE INJECTION TREATMENT OF HERNIA

A DETERMINATION OF ITS INCIDENCE

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STERILITY has been impugned as a complication of the injection treatment of inguinal hernia in the male. This suggestion occasioned the writer to investigate the potential sterility of patients with bilateral inguinal herniae who had been subjected to this type of treatment. No one has apparently deemed it necessary to inquire into the question of possible sterility following the operative repair of hernia. That the possibility for such an occurrence exists is evident in that in large series of operations, undertaken for the cure of indirect inguinal hernia, postoperative swelling of the testis appears as a complication in about 6 per cent of cases, such postoperative testicular swelling leaves the patient with an indurated, enlarged, or atrophic testis (Taylor,<sup>8</sup> Cattell and Anderson<sup>1</sup>). The occasional swelling of the spermatic cord accompanying the injection treatment of hernia prompts this investigation.

The problem of impotence is not to be confused with that of sterility. Impotence is a disturbance of function, sterility a failure of reproduction. A man may be impotent but fertile, and *vice versa*. Impotence presents varying degrees of disturbance of normal coitus, from premature ejaculation to total loss of erection. The causes of impotence may be primary or functional (loss of potency from psychic inhibitions) or secondary to organic pathology

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(loss of potency due to a lesion in the genitalia, the endocrines or nervous system (Hinman<sup>2</sup>) Ripe spermatogenesis, free seminal transmission and successful coitus are the prerequisites for fertility in the male

Theoretically it is conceivable that injecting a sclerosing solution around the inguinal canal might cause stricture or obstruction of the vas deferens or injury of the nerve or blood supply to the cord or testis. Actually, however, Rice,<sup>5</sup> in a series of 30 cases of hernia that had received injections but who were later subjected to operation, observed no difference in the cord as compared to normal. A few had as many as six to eight injections, the rest less than two. If there is a mechanical factor involved, one would think that sterility more than impotency would be affected. Rubin<sup>6</sup> thinks that impotency is largely psychic, and that in only 5 to 10 per cent of cases is there a mechanical defect.

To date, 75 patients with unilateral inguinal hernia treated within the last two years at the University of Minnesota Outpatient Clinic have been questioned individually as to their potency. They were questioned as to libido, frequency of erection and intercourse, *etc*, before and after hernial injection, trying to control other factors (age, neurosis, prostatitis, *etc*). Seventy-four patients stated that they had noticed no difference. One patient, a healthy male, age 43, stated that his libido was definitely decreased for three months following his injections. The sterility factor was not investigated in the unilateral cases.

More suitable for this type of study is the patient who has received injections for bilateral inguinal herniae. Twenty-six such cases were investigated. All were males, and the ages ranged from 20 to 72. These patients had received from four to 28 injections. No case had been followed for more than three years. Of the 26, two claimed there was a decrease in libido following injections. One, a neurotic male, age 52, who had been treated for bilateral indirect inguinal herniae, chronic prostatitis, varicose veins and hemorrhoids, stated that he began to have painful erections after three years of injection treatments, causing him to avoid intercourse. The other patient, a male, age 20, who admitted extramarital intercourse and who might be diagnosed as having a mild case of satyriasis, complained that for five months after 13 bilateral injections he had less libido and less frequent erections.

To study the possible sterility in these treated cases of bilateral inguinal herniae, ejaculation tests were performed. If this was unsuccessful, prostatic smears were examined for spermatozoa. In health, a normal male is capable of producing and ejaculating 3 to 5 cc. of semen containing 300 to 400 millions of spermatozoa (Rubin). Following this criterion, in 15 cases in which ejaculation tests were performed after treatment, all were normal. In two cases, ejaculation tests were obtained before and after treatment, one of the patients had had an operative repair on one side. In eight patients from whom prostatic smears were obtained, no spermatozoa were found. Three of these cases

had a chronic prostatitis. The unreliability of prostatic smears as a test for fertility has been noted by Wangenstein.<sup>9</sup>

**SUMMARY**—In this study the incidence of sterility and impotency as a complication following the injection treatment of hernia is not impressive. In a series of 26 bilateral inguinal herniae, followed up to three years, ejaculation tests were performed in 15, all of which showed normal fertility. Two patients, both of whom showed abnormal mental traits, complained of less libido three months and five years, respectively, after hernial injections. In a series of 75 unilateral inguinal herniae, followed up to two years, only one complained of less libido after a course of sclerosing injections. As to impotency following injections, the type of patient is probably the most important factor.

#### CONCLUSIONS

Twenty-six patients who had received injections for the cure of bilateral inguinal herniae submitted to semen examinations to test their potential fertility. In all, spermatozoa counts within the normal range were obtained. Sterility would not therefore appear to be a complication of the injection treatment of hernia. Fear of such an occurrence should not deter employment of this method in the treatment of selected cases of inguinal hernia.

#### REFERENCES

- <sup>1</sup> Cattell, R. B., and Anderson, C. End-Results in Operative Treatment of Inguinal Hernia. *New England Jour. Med.*, 205, 430, 1931.
- <sup>2</sup> Hinman, F. Principles and Practice of Urology, 831, W. B. Saunders, 1935.
- <sup>3</sup> McMillan, W. M., and Cunningham, D. R. The Injection Treatment of Hernia. *J. A. M. A.*, 106, 1791, May 23, 1936.
- <sup>4</sup> Nelson, A. N. Personal Communication. Dept. of Pathology, Univ. of Minnesota.
- <sup>5</sup> Rice, C. O. The Rationale of the Injection Treatment of Hernia. *Minn. Med.*, 18, 623, 1935.
- <sup>6</sup> Rubin, I. C. Sterility. *Lewis System Surg.*
- <sup>7</sup> Strauss, O. A. Injection Method for Hernia (Correspondence). *J. A. M. A.*, 105, 1702, November 23, 1935.
- <sup>8</sup> Taylor, A. S. The Results of Operation for Inguinal Hernia. *Arch. Surg.*, 1, 382, 1920.
- <sup>9</sup> Wangenstein, O. H. The Undescended Testis. Its Fate after Satisfactory Scrotal Anchorage. *ANNALS OF SURGERY*, 102, 875, 1935.

# THE VALUE OF PARTIAL PANCREATECTOMY IN CONVULSIVE STATES ASSOCIATED WITH HYPOGLYCEMIA

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THE successful treatment of disorders of the glands of internal secretion by operative methods is one of the great triumphs of modern surgery. The earliest important advance in this field was made in the treatment of goiter where the removal of a sufficient amount of overfunctioning thyroid tissue was followed in most instances by the relief of symptoms. As clinical experience increased, dysfunction in other endocrine organs was recognized and in time definite glandular syndromes were established for which relief by surgical measures was sought. Important among these were diseases of the gonads, the parathyroids, the pituitary gland, the adrenals and the pancreas.

The surgical treatment of hyperinsulinism may be said to be in its pioneer stage, nevertheless, the history of its development even thus far is of considerable interest. Seale Harris, in 1923, is credited with having hypothesized the clinical concept of hyperinsulinism. In 1924,<sup>4</sup> he was able to collect several cases with nervous symptoms and low blood sugar readings. Parker and Finley,<sup>7</sup> in the same year, also published reports on ten cases with hypoglycemic manifestations which could be reasonably explained on the basis of excessive insulin production within the body. It was not, however, until Wilder, in 1927,<sup>11</sup> published the result of an operation performed upon a patient by W. J. Mayo, that the hypothesis of Harris received verification. The patient in this instance had a malignant tumor of the pancreas with metastases to the regional lymph nodes and the liver. The most interesting thing about this tumor, however, was that it was composed of cells resembling the cells of the Islands of Langerhans. Following Wilder's article, sporadic reports of similar cases began to appear in the literature. In the vast majority, the symptoms were far too mild to demand radical measures for relief but in a recent review of the subject by Whipple<sup>10</sup> a total of 57 cases with tumors of the pancreas was collected. Of these 57 cases, however, only 27 actually had hypoglycemic symptoms. Thirty of the cases were without recorded hypoglycemia. Of these 27 cases of tumor with hypoglycemic symptoms, there were 18 in which the tumor was found at operation and nine in which the tumor was found at necropsy. In addition there were 18 other cases of hypoglycemia in which no tumors were found, 15 of these by surgical exploration and three by necropsy. Of these 15 operative cases without adenoma, the pathologists reported a normal pancreas in ten, pancreatitis in



three, hypoplasia in one, and hypertrophy in one. In the three cases coming to necropsy all were said to exhibit hypertrophy of islet tissue. It must be admitted, however, that it is an exceedingly difficult task, for pathologists to recognize significant departures from the normal number and volume of islets in histologic sections by ordinary methods. Bensley<sup>1</sup> and later Thompson<sup>9</sup> have made accurate enumerations of the Islands of Langerhans in man and laboratory animals and the methods employed by these investigators appear far too complicated and laborious for routine pathologic diagnoses.

Unfortunately, it will be noted after analysis of the foregoing figures of Whipple that in almost two-thirds of the cases with hypoglycemia there was no demonstrable tumor present so that the operator had to assume (1) That the pancreas was normal and the hypoglycemia was perhaps of extra-pancreatic origin, (2) that there was a more or less diffuse hyperfunction or hyperplasia of islet tissue or (3) the existence of a small adenoma hidden deep within the parenchyma of the gland, not evident on ordinary inspection and palpation. However the case, the majority of surgeons, when faced with this situation, have, after thorough exploration of the abdomen has failed to reveal any other pathology, attempted the ablation of varying amounts of the pancreas, probably on the assumption that a hidden tumor might luckily be brought to light or that extirpation of sufficient pancreas might so reduce the total amount of insulinogenic tissue that the symptoms of hypoglycemia, whatever the cause, might be completely relieved or at least brought under partial control.

The results of surgical treatment have been truly astonishing in patients with definite tumor tissue but in the patients without pancreatic tumors the results have been much less satisfactory. The experimental investigations of Houssay and his coworkers<sup>5</sup> on the importance of the pituitary gland in relation to carbohydrate metabolism in laboratory animals may eventually have a significant bearing on the judgment and decision of the surgeon when at operation he finds no definite pancreatic, adrenal, hepatic or gonadal pathology. At all events, their studies on the correlation between the anterior hypophysis (diabetogenic hormone) and the pancreas are most interesting and very possibly explain the hyperinsulin syndrome in patients without pancreatic adenomata. It is most unfortunate that at the present time there is no satisfactory way of distinguishing the several possible varieties of hypoglycemia from one another. For example, it would be most desirable to differentiate the types due to disturbance in other viscera such as the liver, adrenals, gonads and pituitary gland from those originating primarily in the pancreas. Berry<sup>2</sup> has made the interesting suggestion that in functional hyperinsulinism as opposed to adenoma, increasing doses of glucose are necessary in preparing blood sugar curves, which tend to be lower with larger doses. Furthermore, he believes that starvation causes a rise in blood sugar in functional hyperinsulinism.

Appended is a report of six cases exhibiting convulsions and hypoglycemic sugar tolerance curves which were studied in association with Dr

Broun of the Medical Service at Firmin Desloge Hospital The operative technic has been described in a previous publication<sup>5</sup>

**Case 1**—C Z, white male, single, age 20, was admitted to the Firmin Desloge Hospital October 22, 1934, complaining of convulsions occurring periodically during the past three years These seizures occurred usually at night and were characterized by complete unconsciousness and generalized convulsions The patient had a voracious appetite and was particularly fond of sweets There were no previous diseases of importance and the family history was entirely negative The neurologic and general physical examinations were essentially negative Blood pressure 115/77 Roentgenologic examination of the chest revealed a chronic bronchitis and a moderate degree of cardiac enlargement

*Laboratory Data*—Urine negative Blood Leukocytes, 6,050, erythrocytes, 4,560,000, hemoglobin, 89 per cent Blood Wassermann, negative The sugar tolerance curves, November 23, 1933, and October 5, 1934, were low (Chart 1) The maximum blood sugar was 104 mg per 100 cc and the minimum blood sugar was 52 mg per 100 cc of blood A diagnosis of possible hyperinsulinism was made and on October 27, 1934, a subtotal pancreatectomy was performed, 8 Gm of tissue being removed from the tail of the pancreas

*Pathologic Examination*—The pancreas was sectioned at intervals of a few micra each, without finding any adenoma The islet tissue was markedly increased due to an increase in number rather than in size There was one small area of fat necrosis and pancreatic degeneration

After operation the patient continued to have convulsions which for a time occurred with about the same frequency but with greater severity than prior to operation Since July of 1935, however, the attacks have been somewhat milder and not nearly so frequent Chart 2 shows chronologically, the frequency of major seizures before and after operation Sugar tolerance tests were performed December 4, 1934, and March 4, 1935 The former was in the hypoglycemic zone but the latter was within normal limits

**Case 2**—E T, male, age 17, was admitted to the hospital November 9, 1934, complaining of "fits" His illness had begun four years ago with a seizure characterized by unconsciousness and generalized convulsions These attacks frequently occurred after arising and just before breakfast Not all the attacks were accompanied by unconsciousness and convulsions, for occasionally they were very mild with mental confusion only There was nothing of interest in his previous or family history The general physical and neurologic examinations were essentially negative Blood pressure 134/85

*Laboratory Data*—Urine negative Blood Leukocytes, 9,000, erythrocytes, 5,060,000, hemoglobin, 14.9 Gm The differential count was normal and the blood Wassermann negative The sugar tolerance curves, made September 29, 1934, and November 10, 1934, were low (Chart 1) The maximum blood sugar was 100 mg and the minimum 45 mg per 100 cc of blood A diagnosis of possible hyperinsulinism was made and November 23, 1934, the abdomen was explored Nothing pathologic was encountered and a subtotal pancreatectomy was performed, 22.5 Gm of the gland being removed

*Pathologic Examination*—There were some areas of fat and pancreatic necrosis with leukocytic infiltration, showing them to be preoperative, which I am unable to explain Some focal areas of necrosis without cell reaction may be postmortem The island tissue was markedly swollen, edematous and congested No tumors could be found The islands were not particularly numerous and not noticeably increased in size Impression Hyperfunction of the Islands of Langerhans

This patient made an uneventful convalescence but there was a recurrence of the seizures during the first month postoperatively Chart 2 shows a steady diminution in the frequency of attacks during the 10 month period after operation but since December, 1935, the seizures have again become quite severe and are even more frequent now than before operation A sugar tolerance test December 14, 1934, was still within the hypoglycemic zone in the first and second hours

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Case 3—H S, female, age 26, was admitted to the Firmin Desloge Hospital November 5, 1934, complaining of attacks of unconsciousness, pain in the lower abdomen and irregular menstruation Her first convulsion was said to have occurred at the age of two In successive years the seizures were infrequent until the advent of puberty, when they

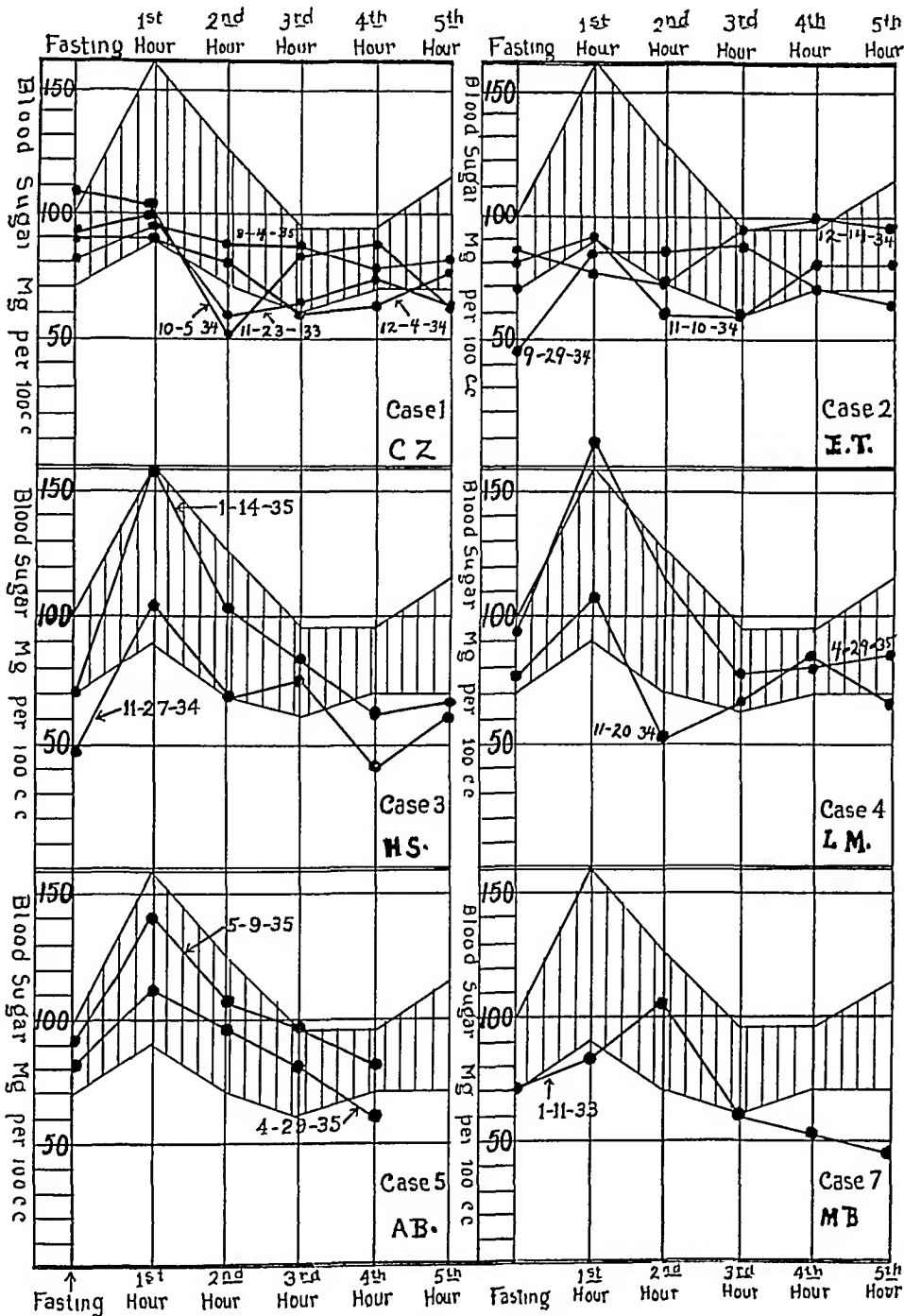


CHART 1 —Blood sugar determinations made before and after operation The shaded area represents the zone for normal readings, by the Shaffer Hartmann method The earlier dates are preoperative, the later ones are postoperative

increased in frequency and severity The attacks always occurred at the time of menstruation and were grand mal in type They were generally preceded by an aura, the character of which she found impossible to describe The patient has been married for four years There was complete absence of libido The menses were very irregular and the flow prolonged About four months prior to admission she began to complain of

pain, of a sharp stabbing character, occurring intermittently across the lower abdomen. This pain radiated both upwards and downwards and generally lasted for one-half to three-quarters of an hour. There were no previous illnesses of importance. The patient's mother suffered from epileptiform seizures which began at the age of 24 following a panhysterectomy.

The physical examination was negative except for moderate tenderness and muscle spasticity in the lower abdomen, particularly in the left lower quadrant. No definite masses could be felt. The pelvic examination revealed a second degree retroflexion with version and a first degree procidentia. Obesity prevented accurate palpation of the adnexa. A roentgenogram of the skull revealed an irregular, partly calcified shadow in the temporal region. Stereoscopic examination some days later failed to reveal this shadow but showed instead a condensation of bone in the inner table in the frontal region. It was felt, therefore, that there were not sufficient data from the roentgenologic standpoint to establish the diagnosis of a brain tumor. An ophthalmologic examination was negative and there were no abnormal neurologic findings. Ventriculograms did not show any definite indications of a cranial lesion.

*Laboratory Data*—Urine, negative. Blood Leukocytes, 6,800, erythrocytes, 4,570,000, hemoglobin, 13.2 Gm. Blood Wassermann, negative. A sugar tolerance curve made November 27, 1934, was low (Chart I). The maximum blood sugar was 104 mg and the minimum 40 mg per 100 cc blood.

A diagnosis of questionable hyperinsulinism was made and on January 3, 1934, the abdomen was explored. Both ovaries were much larger and firmer than normal. The left was the larger, and measured  $5 \times 3 \times 3$  cm, and there was one very hard, nodular area at the inner pole. A piece was removed from this area for microscopic section. The kidneys and the abdominal aorta felt much smaller than one would normally expect. The pancreas presented no evidence of an adenoma, and the liver and adrenals appeared normal. Accordingly, a subtotal resection of the pancreas was performed, removing 40.2 Gm. This amount appeared to be approximately 80 per cent of the whole pancreatic mass.

*Pathologic Examination*—The ovary shows extreme fibrosis with a few imprisoned cystic follicles. The lesion appears to be a benign neoplastic growth rather than an inflammatory mass. The pancreas itself exhibits no pathology.

The wound healed with some difficulty, as a fistula developed which drained for about two months before closing. The seizures continued after operation but the patient is insistent that they are less severe than previously. Chart 2 shows that the convulsive attacks occur with about the same frequency after operation as they did before. A sugar tolerance test, January 14, 1935 was within the hypoglycemic zone in the 4th and 5th hours.

**Case 4**—L. M., male, age 27, was admitted to the hospital March 27, 1935 complaining of "fainting spells" which had begun seven years previously. These seizures, which were sometimes grand mal and at others petit mal in type, occurred from 10 to 15 times daily. Lately, they had been becoming more severe. His past and family histories were irrelevant. The physical examination was entirely negative, except for moderate tenderness on deep palpation in the right iliac fossa. The neurologic examination was also negative. Blood pressure 110/65.

*Laboratory Data*—Urine, negative. Blood Leukocytes, 9,600, erythrocytes, 4,850,000, hemoglobin, 85 per cent. The Kahn and Wassermann tests were negative. A sugar tolerance curve made November 20, 1934, was low (Chart I). The maximum blood sugar was 110 mg and the minimum 52 mg per 100 cc of blood.

A diagnosis of possible hyperinsulinism was made and on March 28, 1935, the general abdomen and pancreas, in particular, were carefully explored. Nothing abnormal could be found. A subtotal pancreatectomy was performed, 23 Gm of pancreatic tissue being removed.

*Pathologic Examination*—The gross material consisted of 23 Gm of pancreatic tissue. It was of light pink color and quite "meaty." It was of firm consistency throughout and had the "ropy" feel of the normal pancreas. Lobulation was quite evident, and

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these structures separated with little difficulty. There appeared to be no abnormal amount of fat associated with the gland. Small pieces were cut from the pancreas and fixed in Zenker's solution.

The paraffin technic was employed and sections were stained with hematoxylin-eosin as well as with Bensley's special stain for islet tissue granules. The microscopic examination of the sections stained with hematoxylin showed a slight fatty infiltration of the gland. The acini appear relatively exhausted of secretion. Generally speaking the islet tissue was pale and appeared to be vacuolated. The capillaries stood out strikingly, due to congestion. Some islet cells had giant nuclei. One section presented a rather large collection of islet tissue. This was quite distinctly set apart from the rest of the organ by slight, but definite, fibrous tissue encapsulation. The adenoma, when examined after special staining for granules, revealed both A and B types. The B type cells were much



FIG. 1—Low power photomicrograph showing the gross dimensions of the adenoma. A definite capsule may be noted. Compare size with that of adjacent normal islets and acini.

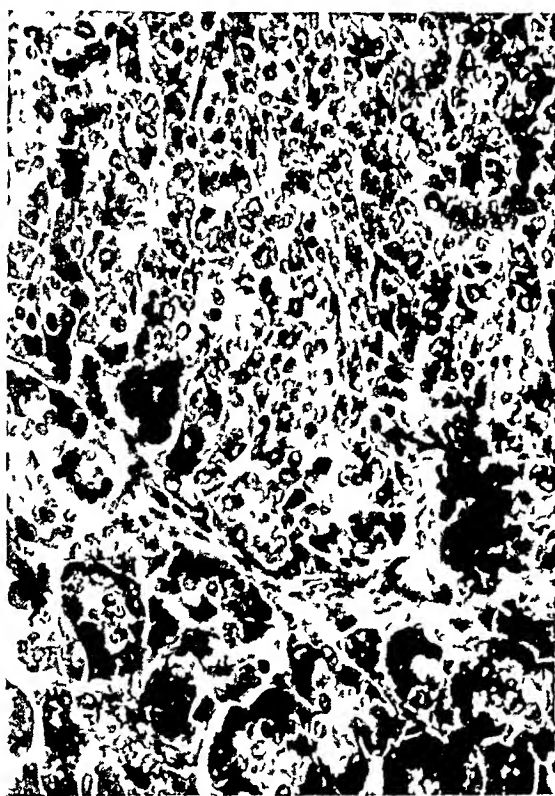


FIG. 2—High power photomicrograph of the islet cell tumor showing the character of the cells. A portion of the capsule is seen. Special granule stains revealed both A and B cells, with the latter predominating.

more numerous than the A. Only the one adenoma was found. Its location was in the tail of the pancreas (Figs. 1 and 2).

Following operation there was an uneventful recovery except that there was a persistence of the convulsions. The patient was discharged from the hospital November 29, 1934. He was very uncooperative in carrying out the after treatment, particularly with reference to overindulgence in alcohol, and he appeared at the clinic from time to time complaining of seizures of greater frequency and intensity than before operation. Because of his general lack of cooperation with our after management on the outside, he was readmitted to the hospital October 21, 1935.

A second exploration of the pancreas was undertaken October 29, 1935, with the view of resecting more of the gland if possible. This was considered justifiable because of our previous finding of a small islet cell adenoma and because of the totally disabling nature of his disease.

An attempt was made to resect more of the gland but it was found too hazardous because of the dense fibrous adhesions which had incorporated the splenic vessels, inferior mesenteric vein and the distal end of the amputated pancreas en bloc. A large pale pinkish nodule lying between the head of the pancreas and the duodenum was identified by frozen section as a lymph node and not an adenoma. After an uneventful recovery the patient was discharged November 22, 1935. Since his second operation, the attacks, while no less frequent, are considerably milder. Chart 2 shows the relative frequency of convulsions before and since the first and second operations. Since January, 1935, the number of seizures per month has been greatly reduced, but recently (not shown on the Chart) they have recurred with the same intensity and frequency as before operation.

**Case 5**—A B, white, female, single, age 50, was admitted March 28, 1935, complaining of attacks of loss of consciousness with convulsions. She had had five major attacks since January 1, 1934, and seizures of minor character occurred almost daily. For the past three years she has complained of vertigo brought on by any quick change of body position. In 1930, she was in an automobile accident and sustained a depressed fracture of the skull in the left frontal region, a fractured clavicle and fractures of several of the bones of the right hand. In 1931, an operation gave relief for pressure symptoms over the right eye of which she was complaining. With regard to her earlier medical history she stated that she had had cerebrospinal meningitis at the age of five, bronchopneumonia at 17 and in 1935 a nephrectomy of the right kidney. In 1925, she had an hysterectomy, left oophorectomy and partial right oophorectomy and appendicectomy.

The physical examination was essentially negative. The scars of the previous operations were evident. The heart sounds were distant and the rhythm somewhat irregular with an occasional dropped beat. Blood pressure 115/65.

*Laboratory Data*—Urine negative. Blood Leukocyte and erythrocyte count and the hemoglobin estimation were normal. The Schilling differential was also normal. The sugar tolerance tests made April 29 and May 9, 1935, are shown in Chart 1. The maximum blood sugar was 140 mg and the minimum 62 mg per 100 cc blood.

A presumptive diagnosis of hyperinsulinism was made and on May 22, 1935, the abdomen was explored. The adhesions of her former operations were so numerous that examination was directed toward the pancreas without further delay. The tail of the pancreas could not be mobilized nor adequately visualized because of its position (much farther to the left than I had previously encountered). The tip of the tail was attached by a fairly good-sized vascular pedicle high up under the left costal margin. To liberate it without more adequate exposure, which it did not appear possible to secure, seemed too dangerous inasmuch as a hemorrhage from this source had nearly proved fatal in a previous operation. Accordingly, a wedge of tissue weighing about 5 Gm, which had been devitalized and traumatized by the holding forceps, was resected and the abdomen closed with drainage.

*Pathologic Examination*—The sections showed a moderate degree of fatty infiltration which was chiefly intralobular. There was some variation in the size of the acini, some being atrophic. The islet tissue was in rather large collections and was somewhat hyperplastic. It was not vacuolated, fibrous or hyalinized. The presence of hemorrhage was considered to be the result of operative trauma.

This patient subsequently developed a pancreatic fistula which will be reported elsewhere. In the 11 months' period following operation, there have been three convulsions of the major type but she states that she has been relieved entirely of her petit mal seizures. Chart 2 shows the frequency and severity of these hypoglycemic attacks before and since operation.

**Case 6**—I J, white, female, single, age 24, was admitted to the Firmin Desloge Hospital, May 11, 1935, complaining of abdominal pain and "epileptic fits." She had had these generalized convulsive attacks with loss of consciousness for nearly 20 years. They occurred every seven to ten days particularly just preceding or just following her menses. She had noted an aura. The attacks of abdominal pain which began at about the age of five were moderately severe and were confined to the umbilical region. They were fre-

quently associated with the convulsive seizures. In childhood the attacks were far more frequent than they are at present.

The physical and neurologic examinations were essentially negative except for a slight tenderness on deep palpation over McBurney's point. There was no tenderness in the region of the navel and no masses could be felt anywhere. Blood pressure 130/79.

*Laboratory Data*—Urine, negative. Blood Leukocytes, 7,500, erythrocytes, 2,840,000, hemoglobin, 13.0 Gm. The Wassermann test was negative. A number of sugar tolerance tests were made and these revealed curves entirely within the normal zone. Roentgenologic examinations of the skull, gallbladder, esophagus and gastro-intestinal tract were all negative.

A diagnosis of chronic recurring appendicitis was made and on May 24, 1935, the appendix was removed through a right midrectus muscle splitting incision. The pancreas was exposed through the gastrocolic omentum and examined as well as possible, but no adenomata could be discovered. Pathologic examination of the appendix showed scarring, fatty changes and lymphoid hyperplasia with granulations and focal gatherings of round cells.

The patient made an entirely uneventful operative recovery. She was discharged June 10, 1935, but continued to have convulsions and attacks of abdominal pain precisely as before operation. She was readmitted December 18, 1935. Intravenous pyelograms were made to exclude possible renal or ureteral pathology. On reexamination of the abdomen it was still possible to elicit tenderness on deep palpation in both lower quadrants.

A presumptive diagnosis of hyperinsulinism was made on the basis of the convulsions and associated central abdominal pain and on December 20, 1935, the pancreas was exposed, through an upper left midrectus incision. A complete abdominal exploration revealed nothing pathologic. The pancreas was partially resected, removing 35 Gm. of tissue. Some difficulty was experienced with the dissection because of adhesions from the previous operation, but the gland was finally divided at a distance of 2.5 cm. from the duodenum.

*Pathologic Examination*—The gross pancreas submitted for study was distinctly lobulated and the lobules separated with little difficulty. The gland substance appeared red rather than the more usual pink, but this seemed to be due to some hemorrhage within its substance. Only a slight amount of peripancreatic fat was seen.

Many small blocks from widely different areas were cut, fixed and stained with hematoxylin-eosin. All veins of the pancreas were noticeably engorged with blood. Hemorrhage was also found, particularly in the interlobular connective tissues. The congestion and hemorrhage were considered to be due to operative trauma. A slight fatty infiltration of the gland was noted. Generally speaking the ducts and acinar structures of the pancreas were not remarkable. Sections made from the tail of the organ show a very large number of islands, which would be expected. The capillaries in their substance are extremely prominent because of congestion which may again be due to necessary operative trauma. Many of the islands are rather strikingly large. This does not seem to be due to any exudative reaction, as there is no separation of the tissue by cellular or fluid exudate.

At one point, near the periphery of the pancreas, in a periductal position, are many large (microscopically) collections of islands. These are entirely set apart from the acini between them. The individual collections are surrounded with fibrous tissue. Cytologic study reveals normal islet tissue composing these collections.

The immediate course after operation was uneventful. The convulsive seizures continued but she states that they are less severe now than before operation. Chart 2 shows the same relative frequency of convulsive seizures before and since operation. The normal character of the blood sugar curves has not been altered. The attacks of abdominal pain were relieved temporarily but have lately recurred.

*Case 7*—This patient did not come to operation but the opportunity of securing postmortem material in these cases is so unusual that we have included it in this series. Whipple reports only three necropsies in his group of 18 cases of hypoglycemia without



tumors Unfortunately, we did not receive the pituitary gland for study but it is particularly interesting to note that no definite lesions were found anywhere in the entire pancreas

M B, female, single, age 25, was admitted to the Firmin Desloge Hospital November 6, 1933 She complained of convulsive attacks which had begun at the age of

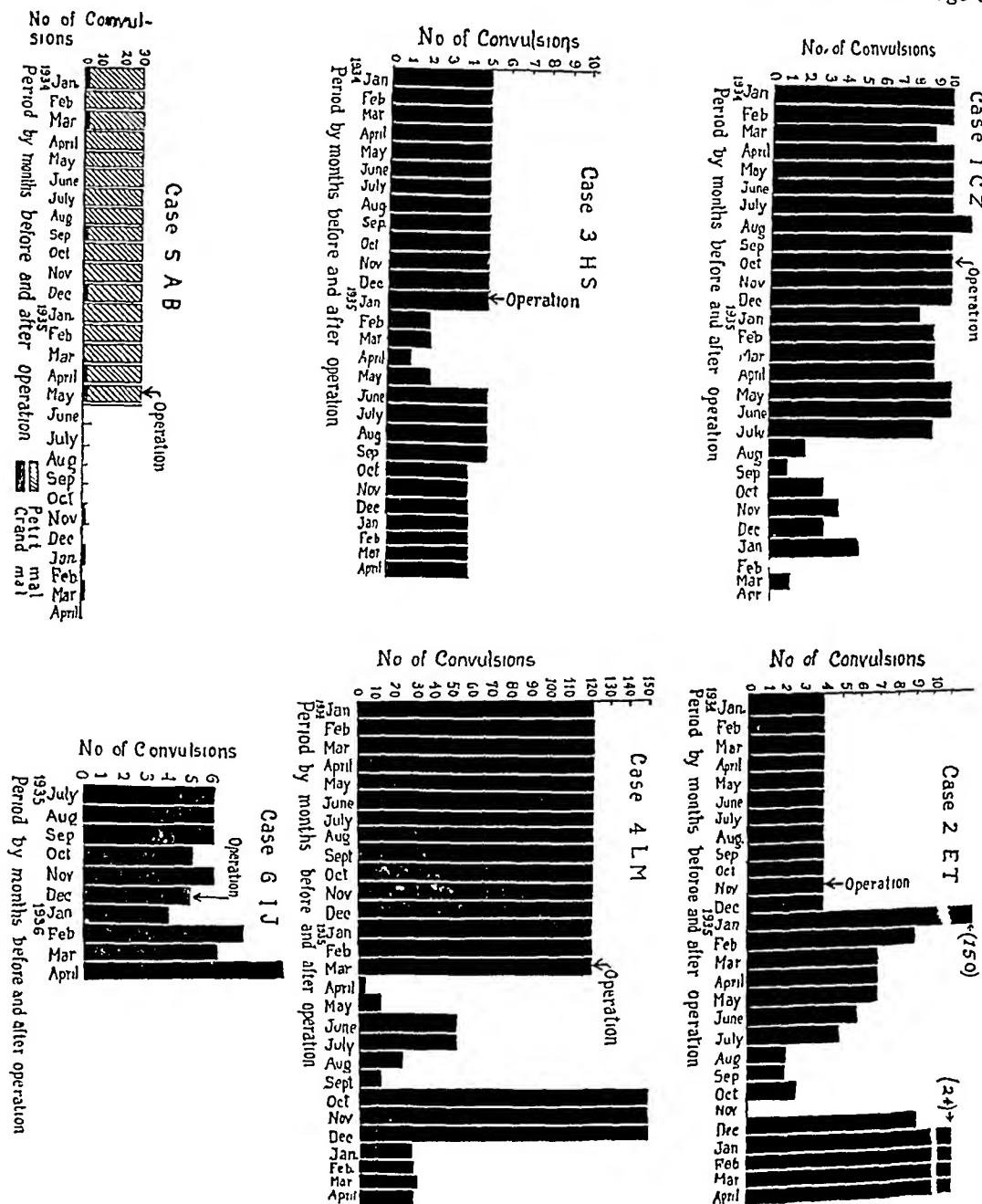


CHART 2—Shows the frequency distribution of convulsions before and after operation

II The description of the attacks given by relatives was that of a typical grand mal seizure They seemed to increase in frequency at the time of her menses There were no previous diseases of importance and no familial disorders The physical examination was essentially negative, the neurologic examination was negative except that she appeared mentally retarded Blood pressure 120/90

**Laboratory Data**—The blood and urine were negative The Kahn test was negative The sugar tolerance test January 11, 1933, was low (Chart 2) The maximum blood sugar was 105 mg and the minimum, 45 mg per 100 cc



## PARTIAL PANCREATECTOMY

She was discharged December 9, 1933, with a presumptive diagnosis of hyperinsulinism and advised to return to the Dispensary for observation and treatment. On November 6, 1934, she was urged to enter the hospital for a surgical exploration of the pancreas. She, however, fell in the street and received what appeared, at the time, to be a trivial head injury. She was put to bed immediately and died unexpectedly a few hours later. At a coroner's inquest, the cause of death was attributed to a linear fracture of the skull into the left orbital fossa with a subarachnoid hemorrhage. The pancreas was obtained and submitted to Dr. Collier for study.

*Pathologic Examination*—A small accessory lobule was found in the pancreas near the junction of the body with the tail. The sections showed diffuse hypertrophy of the Islands of Langerhans. There were no adenomata anywhere in the gland.

**DISCUSSION**—The literature on the surgical treatment of hyperinsulinism has been reviewed and seven patients of our own, six of whom had had convulsive states associated with hypoglycemia, have been reported. Six of these patients were treated surgically by partial pancreatectomy. In only one patient did we find a tumor. In none of our six patients was there complete relief of the hypoglycemic convulsions, but there was some slight measure of improvement in three of the patients and none whatever in the remainder.

The surgical exploration of the pancreas, however, seems justifiable in those cases in which hypoglycemic sugar tolerance curves are found associated with frequent and severe convulsions which fail to respond at all to proper medical management. The incidence of hyperinsulinism particularly in its minor manifestations is far more common than has been supposed<sup>1</sup> but these patients may be dealt with satisfactorily by medical means. Unfortunately there is as yet no definite clinical method for differentiating hypoglycemic conditions which arise in the pancreas from those of extrapancreatic origin. Surgical exploration seems to be the only possible method of ascertaining the existence of adenomata and even this method is not altogether reliable as shown in Case 4, in which a very small adenoma of islet cells was discovered in the microscopic sections after the gross specimen had been reported normal.

The results in our series of patients were very unsatisfactory, as in not a single instance was a cure obtained. Nevertheless, our results are in keeping with the majority of the cases of resection of the pancreas for hyperinsulinism without tumors, reported in the literature. For example, in Whipple's collection of 18 cases with islet cell tumors removed at operation, 14 were completely free of symptoms after operation, three were improved and one patient had a malignant neoplasm and did not recover. On the other hand, in his 15 cases without tumor of the pancreas, the results were variable and much less favorable. In this latter group there was improvement or complete relief of symptoms in six patients and a persistence of the hypoglycemic convulsions, in six. One patient was still convalescing at the time of publication, in one the operation consisted only in a stripping of the capsule and in another a biopsy specimen was all that was obtained.

By way of contrast with the published results in the cases with tumors it will be noted that of 23 cases of hypoglycemic convulsions without tumors reported to date, in which a partial pancreatectomy was performed (Table I),

eight were unrelieved, six were partially improved and in seven there was complete relief. One patient was convalescing at the time of report and another died of pneumonia three days postoperatively and therefore are not included in the table.

Analysis of these figures, Table II shows, for example, that it is practically impossible to correlate the amount of gland tissue resected with the postoperative results because the surgeons in six instances reported the amount removed either in fractions of the total length, in linear units or by anatomic designations such as "tail" or "tail and body," instead of in readily comparable units, such as the weight of the gland tissue resected. Neither may conclusions be drawn with regard to the pathologist's report for it would be necessary to assume that a painstaking examination of thin serial sections was made throughout the entire extent of the gross tissue and this does not seem probable.<sup>8</sup> Furthermore, we have already pointed out some of the difficulties encountered by pathologists in recognizing abnormal variations in size and number of islets.<sup>1, 9</sup>

In eight of the cases in which there was a persistence of the hypoglycemic symptoms and in which there was no evident improvement, the amount of gland removed varied from 5 to 35 Gm. In one case the amount was not mentioned. Of the seven cases in which the tissue had been weighed, the average weight was 16.3 Gm. The pathologic findings in these cases were normal pancreas in five, hypertrophy of the Islets of Langerhans in two and a small islet cell tumor in a normal pancreas in one.

In the six patients in which there was a persistence of the symptoms but who reported that their condition was improved in some degree, the amount of gland resected in five of them ranged from 5.0 to 40.2 Gm. In one case the operator reported the removal of 8 cm. of the pancreas but did not give the weight. The average weight of the five specimens was 17.8 Gm. The pathologic findings in four were normal and in one an hypertrophy of the Islands of Langerhans was noted and in another the islands seemed more numerous than normal.

In the seven patients with no return of the hypoglycemic syndrome after operation, the weight was given in only one case, *i.e.*, 60 Gm. In two cases one-half, in two cases, two-thirds, and in one, seven-eighths, of the gland was resected. In another the amount was represented as the "tail and body." In spite of the fact that the specific weight of the resected portion was given in but one case, it is quite probable that the average for this group would be considerably higher than that of the two preceding groups as the fractions of gland removed are in each instance given as one-half or more of the total gland. The pathologic findings reported in this group were normal pancreas in every instance.

Complete relief was therefore obtained in only one-third of the cases. This is not such a poor showing when the desperate condition of many of these totally incapacitated patients, as well as our ignorance of the etiologic

TABLE I

A REVIEW OF TWENTY-THREE CASES OF CONVULSIVE STATES ASSOCIATED WITH HYPOLYCEMIA  
AND WITHOUT PANCREATIC ADENOMATY, SUBJECTED TO PARTIAL PANCREATICTOMY  
(By Various Authors)

Case No	Author	Reference to Publication	Age and Sex	Duaction of Hypoglycemic Symptoms and Minimum Blood Sugar	Operation	Pathologic Examination	Results
1	Pinney and Pinney	Ti Am Surg Assn, 46, 268, 1928	53—F	4 yrs 30 mg	Resection of $\frac{2}{3}$ or 22.5 Gm of the pancreas	Apparently normal pancreas	Improved Continues to have mild attacks Blood sugar 45-70 mg
2	Judd, <i>et al</i>	J A M A, 94, 1116, 1930	52—M	2 yrs 40 mg	Resection of tail and part of body (14 Gm)	Normal pancreas	Not improved 14 mos
3	Judd, <i>et al</i>	J A M A, 94, 1116, 1930	47—M	4 yrs 40 mg	Resection of 8 Gm tail	Normal pancreas	Not improved 4 yrs
4	Harris, S (Taylor)	J A M A, 1932	20—M	2 yrs 50 mg	Resection of tail and one-half of body	Normal pancreas	Improved Blood sugar 17 mos later was 100 mg
5	Judd, <i>et al</i>	J A M A, 101, 99, 1933	50—M	14 mos 40 mg	(1) May 25, 1931 Resection of 5 Gm of tail of pancreas (2) April, 1933 Portion of pancreas destroyed between clamps	Apparently normal pancreas	(1) Immediate improvement followed by recurrence of hypoglycemic attacks (2) No improvement
6	(1) Holman and Raaback (2) Judd, Allan and Rynearson	Surg, Gynec, and Obst, 59, 591, 1933	31—M	1½ yrs 32 mg	(1) Resection of 8 cm of tail, 1928 (2) Excision of nodule, 1932	(1) Apparently normal pancreas (2) Chronic interstitial pancreatitis	(1) Improved though not entirely relieved of attacks (2) Condition unchanged

TABLE I (Continued)

Case No	Author	Reference to Publication	Age and Sex	Duration of Hypoglycemic Symptoms and Minimum Blood Sugar	Operation	Pathologic Examination	Results
7	Evans and McDonough	Jour Iowa Med Soc, 23, 454, 1933	41—F	1 yr (?) mg	Amount resected unknown	Normal pancreas	Unimproved
8	Ziskind	Arch Int Med, 52, 76, 1933	19—M	18 mos 40 mg	Resection tail 7 2 Gm	Normal pancreas	Unimproved
9	Womack	1933 (personal communication)	35—M	3 yrs 40 mg	Tail and part of body ( $\frac{2}{3}$ )	Normal pancreas	Remained symptom free
10	Womack	1933 (personal communication)	26—M	3 yrs 40 mg	Tail and part of body ( $\frac{2}{3}$ )	Apparently normal pancreas	Improved—No recurrence hypoglycemic convulsions
11	Graham and Hartmann	Surg, Gynec, and Obst, 59, 474, 1934	12 mos —F	9 mos 6 mg "True Sugar"	Resection of $\frac{1}{3}$ of the body and tail	Apparently normal pancreas	Remained well 9 mos
12	Simon	South Surg, 3, 199, 1934	26—M	3 $\frac{1}{2}$ mos 51 mg	Resection and destruction of approximately 60 Gm of pancreas, gland appeared grossly enlarged	Islands of Langerhans enlarged	Recurrence of mild hypoglycemic symptoms for a short time
13	Thomason	(Personal communication), Western Surg Assn, Dec 8, 1934, St Louis, Mo	(?)—M	(?) mos 51 mg	Subtotal pancreatectomy tail and body Splenectomy	No adenoma	Improved, months (?)

# PARTIAL PANCREATECTOMY

14	Harris S (Drennan)	South Surg, 3, 199, 1934	32—F	(?) 60 mg 4 mos (8 yrs)	Subtotal 1/2 body and tail	No symptoms since operation (4 mos) No final report as pa- tient convalescing
15*	Harris, S (Drennan)	South Surg, 3, 199, 1934	27—M	65 mg 14 yrs	Excision 1/2 body and tail	Improved
16	Berry, J A	Brit Jour Surg, 33, 51, 1935	58—F	45 mg 18 mos	Resection tail and part of body (28 Gm)	Death from broncho- pneumonia 3rd day postoperative
17*	Barnes and Richmond	New Eng Jour Med, 213, 225, 1935	35—F	30 mg	Resection of 2 in of the tail	Some improvement Resection of more pan- creatic gland advised
18	McCaughan and Broun	Case 1 (In press)	20—M	3 yrs 54 mg	Normal pancreas	No improvement
19	McCaughan and Broun	Case 2 (In press)	17—M	4 yrs 36 mg	Resection of tail of pancreas (8 Gm)	Death from broncho- pneumonia 3rd day postoperative
20	McCaughan and Broun	Case 3 (In press)	26—F	24 yrs 25 mg	Resection 2/3 body and tail of pancreas (22 5 Gm) appeared grossly normal	Some improvement Resection of more pan- creatic gland advised
21	McCaughan and Broun	Case 4 (In press)	27—M	7 yrs 36 mg	Resection of 40 2 Gm pancreas	No improvement
22	McCaughan and Winer	Case 5 (In press)	50—F	60 mg	Normal pancreas	Slightly improved Severity of convul- sions lessened
23	McCaughan and Broun	Case 6 (In press)	24—F	70 mg	Islet cell discovered in re- sected portion Normal pancreas	Temporary improve- ment, then recurrence
					Resection of 35 Gm pancreas	Slight improvement
					Hypertrophy of Is- lands of Langerhans	No improvement

\* This case is not included in Table II

factors responsible for the convulsive hypoglycemic syndrome, are taken into consideration

TABLE II

AN ANALYSIS OF THE RESULTS OF PARTIAL PANCREATICTOMY IN TWENTY-ONE CASES OF CONVULSIONS WITH HYPOGLYCEMIA

*Correlation of the results obtained, with amount of gland removed and with pathologic findings  
(Reported by Various Authors)*

Postoperative Results	No of Cases	Amount of Pancreas Resected	Pathologic Findings
No improvement	8	5 0 Gm	Normal pancreas—
		7 2 Gm	5 cases
		8 0 Gm	Normal pancreas with
		14 0 Gm	islet cell tumor—
		22 5 Gm *	1 case *
		23 0 Gm *	Hypertrophy Islands of
		35 0 Gm *	Langerhans—
		(?) Gm	2 cases **
		Average Weight 16 3 Gm	
Improvement (some amelioration in the frequency and severity of hypoglycemic convulsions)	6	5 0 Gm *	Normal pancreas—
		7 2 Gm	4 cases **
		8 0 Gm *	No of islands appar-
		28 0 Gm	ently increased—
		40 2 Gm *	1 case *
		8 0 Gm	Hypertrophy of Islands
		Average Weight 17 8 Gm	
Complete relief of symptoms	7	½ (tail and body) 2 cases	Normal pancreas—
		⅔ (tail and body) 2 cases	7 cases
		⅞ (tail and body) 1 case	
		(?) (tail and body) 1 case	
		60 Gm (tail and body) 1 case	
		Average Weight (?) Gm	

\* Denotes cases in our own series

### CONCLUSIONS

Desperate cases of convulsive seizures associated with hypoglycemia unrelieved by proper dietary and medical treatment should be offered the opportunity afforded by surgical exploration. Adenomata if present may be removed with excellent prospects for cure. If no tumors are found, the pancreas can be partially extirpated without undue risk. The amount to be removed will depend upon the severity of the symptoms and the anatomic and pathologic conditions at hand. It is possible to remove the greater part of the human pancreas, apparently without serious disturbances to carbohy-

drate metabolism. If the pathologic findings in the resected portion show islet hypertrophy or small adenomata, a case improved by resection can be offered the benefit of additional resection if conditions are favorable for further operative procedure.

From a study of case reports in the literature it is evident that the end-results of operations in cases with islet cell tumors are excellent, and in patients without adenomata the results, while much less satisfactory, are occasionally gratifying. The results in our own particular series were very disappointing and should, we believe, dampen the enthusiasm of those who may be inclined to recommend surgery for the relief of any, and all, cases of hypoglycemia with nervous manifestations. It seems to us that until a positive method for differentiating cases of pancreatic adenomata from other functional abnormalities of the islet cells, particularly, those due to an imbalance between interrelated endocrines is developed, we will continue to meet with similar unfavorable results from subtotal resections of the pancreas. To add further to the general uncertainty and confusion in this field we have yet to mention that vast diagnostic dumping ground of vague and shadowy boundary—the group of so called idiopathic epilepsies.

To our mind the comparison of subtotal pancreatectomy for hyperinsulinism with the rationale of thyroidectomy for hyperthyroidism, as has been suggested by some, seems scarcely tenable in view of the uncertain and the generally unsatisfactory clinical results thus far reported in those cases without adenomata of islet cell origin.

#### REFERENCES

- <sup>1</sup> Bensley, R. R. Studies on the Pancreas of the Guinea Pig. *Am Jour Anat*, 12, 297-388, 1911-1912.
- <sup>2</sup> Berry, J. A. A Case of Hyperinsulinism Relieved by Partial Pancreatectomy. *Brit Jour Surg*, 23, 51-65, July, 1935.
- <sup>3</sup> Coleman, J. M. A. Study of Hypoglycemia with Particular Reference to Hyperinsulinism. *Bull St Louis Med Soc*, 29, 104, October 26, 1934.
- <sup>4</sup> Harris, S. Hyperinsulinism and Dysinsulinism. *J A M A*, 729, September, 1924.
- <sup>5</sup> Houssay, B. A., and Biasotti, A. Hypophysis, Carbohydrate Metabolism and Diabetes. *Endocrinology*, 15, 511-523, December, 1931.
- <sup>6</sup> McCaughan, John M. Subtotal pancreatectomy for Hyperinsulinism, Operative Technique. *ANNALS OF SURGERY*, 101, 1336-1341, June, 1935.
- <sup>7</sup> Parker, J. F., and Finley, C. S. Some Results Obtained by Treatment of Nervous Phenomena with Glucose. *Proc Soc Exper Biol and Med*, 21, 517, May, 1923-1924.
- <sup>8</sup> Shields, W. Adenomas of the Islands of Langerhans. *Am Jour Path*, 2, 335-340, 1926.
- <sup>9</sup> Thompson, W. R., Tennant, R., and Hussy, R. Frequency-Distribution of Volume of Island of Langerhans in the Pancreas of Man, Monkey and Dog. *Science*, 78, 270-271, September, 1933.
- <sup>10</sup> Whipple, A. O., and Frantz, V. K. Adenoma of Islet Cells with Hyperinsulinism, *ANNALS OF SURGERY*, 101, 1299-1335, June, 1935.
- <sup>11</sup> Wilder, R. M., Allen, F. N., Power, M. H., and Robertson, H. L. Carcinoma of Island of Pancreas, Hyperinsulinism and Hypoglycemia. *J A M A*, 89, 348, July, 1927.

## THE THYROID GLAND IN HYPOGLYCEMIA \*

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IN THE maintenance of body economy it is apparently necessary that the level of sugar in the blood should not be allowed to fall too low. When this does occur, either spontaneously or following the injection of insulin, certain clinical symptoms develop that have been explained as being due to a sudden excessive secretion of adrenalin. Our clinical experience in patients with spontaneous hypoglycemia has tended to confirm this observation on numerous occasions. Apparently, the action of adrenalin under such conditions is to mobilize sugar from the liver, so that the hypoglycemia can be relieved, and in so doing to produce other adrenalin effects in the body with ensuing clinical symptoms. That the adrenal medulla is not the only structure capable of producing an increased glycogenolysis is well known and will be discussed in detail subsequently. Certainly the thyroid gland has such a function and because of the fact that increased activity of the thyroid is generally associated with an increase in glycogenolysis, it has occurred to us that there may also be times in which it may be necessary for the body to utilize the secretion of the thyroid gland in hypoglycemia to maintain homeostasis. With this conception in mind the following case reports are presented.

### CASE REPORTS

**Case 1**—A G, white, male, age 36, was admitted to the St. Louis City Hospital November 6, 1933, with the complaints of nervousness, tachycardia, dizziness and attacks of staggering while walking. His family and previous personal history were quite irrelevant other than that in 1917, following an attack of mumps, the right testicle underwent atrophy, and that he had contracted both gonorrhea and syphilis in 1920. Treatment for the latter was undoubtedly inadequate. He had been only an occasional user of alcohol, but is a heavy cigarette smoker and his consumption of coffee has been rather excessive.

Shortly after the World War the patient began to notice an increase in nervousness. This at first was extremely vague and the patient was unable to describe it accurately. It consisted for the most part in occasional dizzy spells and a sense of palpitation, none of which were severe enough to produce any incapacity. About four years before his admission into the hospital vague digestive disturbances began to appear, evidenced chiefly by constipation, distention and belching after meals. Shortly after this he began to have spells of smothering in which it was difficult to get his breath. This was followed by a marked increase in the frequency and degree of the attacks of dizziness. At times while walking, the patient would have such an attack during which he would stagger in a drunken fashion, not losing consciousness, but at the same time being com-

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pletely disoriented. Palpitation became marked. During this time there was no history of girdle or shooting pains, neither was there any abnormality of gait.

*Physical Examination*—He seemed unusually restless. The pupils were normal and reacted to both light and accommodation. There was a slight exophthalmos which was associated with lid lag. A fine tremor of the tongue was present. The thyroid gland showed a definite diffuse enlargement, no nodules were palpable. The right testicle was atrophic. The rectal sphincter tone was normal. All reflexes were slightly exaggerated and a positive Babinski was present on the right side. The Gordon reflex and Oppenheim sign, however, were negative. A fine tremor was noted when the fingers were outstretched. The patient's hair was abundant and fine.

*Laboratory Data*—The spinal fluid was found to be under normal tension. It contained six cells, and the colloidal gold determination was negative. The blood and spinal fluid Wassermann reaction was negative. The uranalysis was negative, the blood nonprotein nitrogen was 37 mg per cent, hemoglobin 85 per cent and both red and white blood cell counts normal. Roentgenologic examinations of the skull showed a normal sella, and no evidences of increased intracranial pressure. Those of the chest likewise showed no abnormal findings. The basal metabolism on two determinations was +42 and +37 respectively.

Immediately following his first basal metabolism determination, he suddenly became disoriented and went into an attack of apparent automatic movements for about three minutes, after which he appeared normal. A blood sugar determination taken at this time (14 hours' fasting) showed it to be low. Sugar tolerance determinations following the ingestion of one gram of glucose per kilogram of body weight are shown in Table I.

TABLE I  
RESULTS OF SUGAR TOLERANCE DETERMINATIONS

Fasting	30 Minutes	One Hour	Two Hours	Three Hours
72	117	96	72	62 (11/17/33)
66	133	100	71	47 (11/20/33)

Numerous fasting blood sugars ranged between 60 and 80 mg per cent. All of these determinations were made according to the Folin-Wu method, the true sugar content would therefore be about 20 mg per cent lower.

Rather than perform a thyroidectomy upon this patient, it was decided to explore the pancreas. The rationale for this decision will be considered in discussion of the case.

*OPERATION*—November 11, 1933. Through a left rectus incision the pancreas was approached through the gastrocolic omentum. No gross abnormalities were found on its anterior surface. After freeing the inferior border, the gland was everted and the posterior surface likewise was found to be grossly normal. Exploration of the adrenal glands showed no evidence of enlargement, but this exploration, especially on the right side, was unsatisfactory. It was decided to perform a subtotal resection of the pancreas in order to remove some of the insulin secreting tissue. This was accomplished by removing the tail and most of the body. The stump of the pancreas was sutured over with a running chromic catgut suture and a drain carried down to the lesser sac through a stab wound. The abdominal wound was closed in layers. The postoperative course was uneventful. The drain was shortened after several days and upon its removal there was no fistula formation or any evidence of skin digestion.

*PATHOLOGIC EXAMINATION*—*Gross*. The pancreas showed no evidence of tumor and the tissue appeared normal. *Microscopic* examination showed the islets to be normal in size, number, vacuolization, hyalinization and sinusoids. There was a very definite increase in the proportion of the alpha cells (Dr. James O'Leary).

*POSTOPERATIVE COURSE*—The level of blood sugar remained elevated for several days, gradually coming down to normal. After about two weeks it became apparent that the

thyroid gland was decreasing in size and the eye signs were beginning to recede. A basal metabolism determination at the time of the patient's discharge from the hospital on December 29, 1933, showed it to be zero. An examination to determine his sugar tolerance on January 10, 1934, gave the result as shown in Table II.

TABLE II

## SUGAR TOLERANCE DETERMINATION TWO MONTHS POSTOPERATIVE

Fasting	30 Minutes	One Hour	Two Hours	Three Hours
80	190	235	173	80

The patient stated that most of the symptoms (including the manifestations of goiter) of which he complained had completely disappeared. No iodine medication of any kind was given either before or after operation. Since his operation about two and one-half years ago, the patient has been on relief and extremely difficult to follow. He was seen about two months ago, at which time he stated that there had been no return of his attacks, which we feel was explicable on the basis of his hypoglycemia. His thyroid was not enlarged. What his basal metabolic rate is and what his sugar tolerance curve is, however, we are unable to report upon.

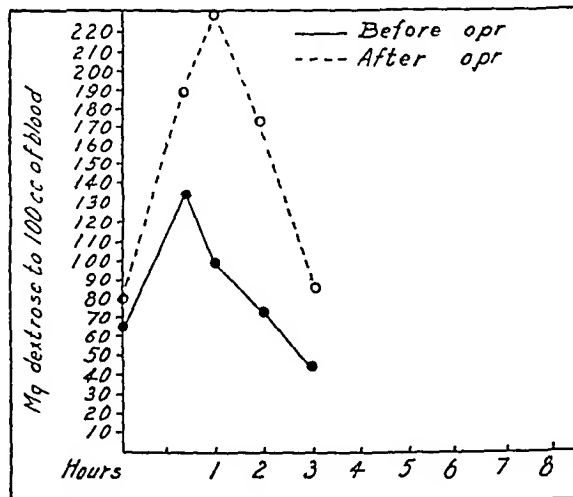


CHART 1—(Case 1) Showing graphically the sugar tolerance curves taken before partial resection of the pancreas and eight weeks after the operation.

For the privilege of presenting the second case we are indebted to Dr S H Gray of the St Louis Jewish Hospital. This case will be reported by him subsequently with others in greater detail, but because it presents morphologic evidence of the concept which we are suggesting, we are including it in our presentation.

**Case 2**—An infant, born of an apparently normal mother, died about two hours after birth, it was comatose at birth and remained so until death. Upon autopsy the pancreas showed an extreme degree of hypertrophy and hyperplasia of the islet tissue (Fig 1 A). The adrenal medulla as well as part of the cortex on both sides was completely destroyed by an old hemorrhage (Fig 1 B). The thyroid gland, instead of showing the usual picture of fetal thyroid, resembled that seen in Graves' disease to a marked extent (Fig 1 C and D). Unfortunately, the hypophysis was lost. A notation made at autopsy, however, states that it was definitely enlarged.

The presence of compensatory hyperactivity of the thyroid is likewise suggested in a case recently under the care of Dr L F Aitken<sup>26</sup> and which

is being reported by him elsewhere. This patient, a married woman of 44, developed symptoms of amnesia, automatism, confusion and unconsciousness occurring before breakfast. Several months later she was said to have had a characteristic clinical picture of Graves' disease, the basal metabolic rate being plus 80 per cent. With the appearance of the hyperthyroidism the symptoms referable to hypoglycemia became less. A subtotal thyroidectomy was performed, following which the hypoglycemic symptoms increased in severity. After the removal of a *Beta* cell adenoma of the pancreas and the return to

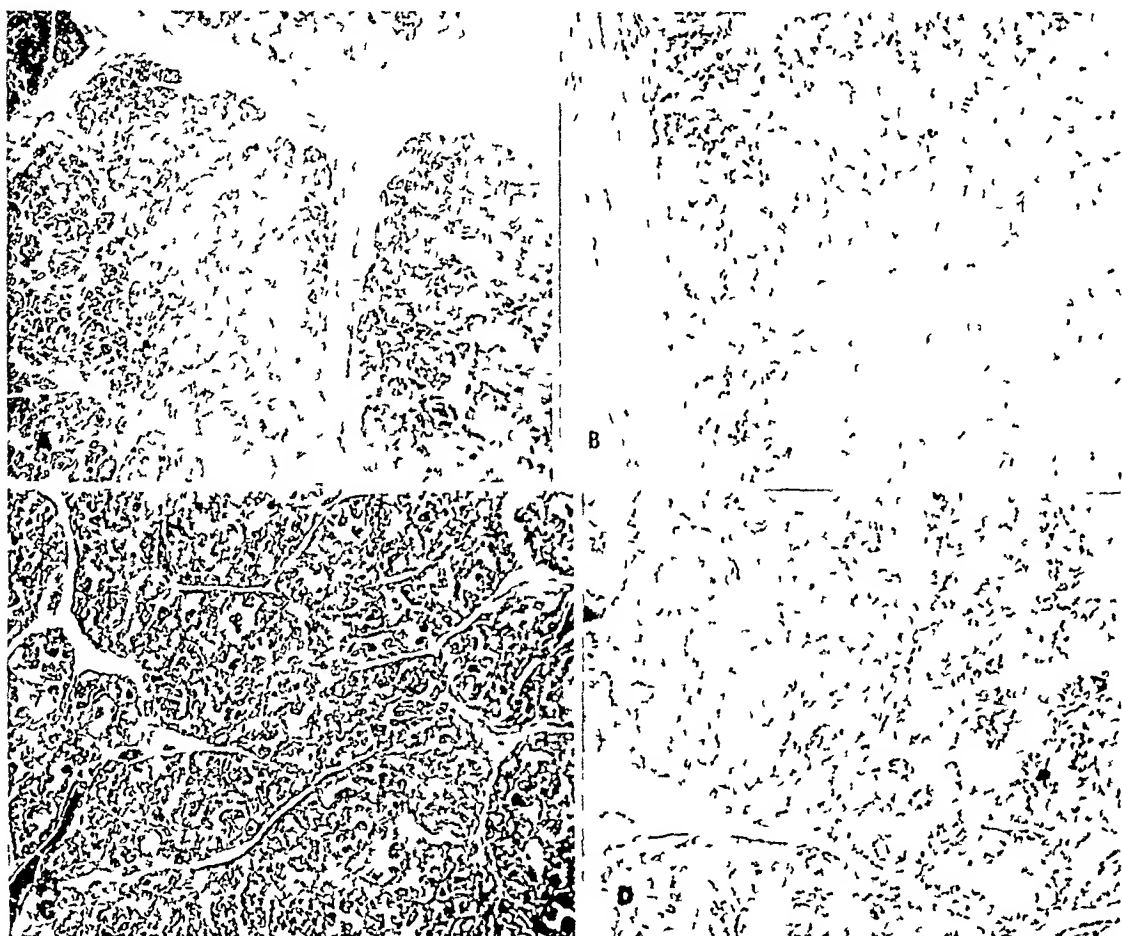


FIG. 1.—(Case 2) Photomicrograph of the pancreas showing hypertrophy and hyperplasia of the islet tissue. (B) Photomicrograph of the adrenal gland showing the medulla completely destroyed by an old hemorrhage that is encroaching on the cortical layer. Both adrenals showed the same change. (C) Photomicrograph of the thyroid gland showing the general architecture. The loss of colloid, hyperplasia and pliciation of the epithelium may be seen (low power). (D) A higher power photomicrograph of the section shown in C. Morphologic evidence of increased thyroid activity is apparent.

apparently normal carbohydrate metabolism, which was several years after the thyroidectomy, the patient developed evidence of hypothyroidism, and now requires one and one-half to two grams of desiccated thyroid per day.

For a number of years it has been suspected by many observers that the primary cause of toxic goiter is probably not to be found in the thyroid itself. It has been felt that the anatomic and physiologic changes brought about by the overfunction of this gland are the result of an unknown stimulus coming from some other part of the body. Indeed, such changes have already been produced experimentally by a varied group of substances. Perhaps the

most striking is that which follows the injection of extracts from the anterior lobe of the pituitary gland<sup>1</sup> We have observed such changes following certain types of infections<sup>2</sup> and toxemias and after the administration of some of the methylated purines<sup>3</sup> Because of the dominant rôle that the thyroid plays in the fundamental activities of the body, it has appeared extremely important to us that this fact should not be lost sight of in studying the pathologic entity of toxic goiter While the interrelationship of all the so called glands of internal secretion in their influence upon the metabolic processes of the body is becoming more and more apparent, especially is this true in carbohydrate metabolism and, although we feel that at the present time this effect is still poorly understood, it occurred to us that it would be of value to review some of the work on the action of the thyroid gland relative to sugar metabolism The two cases that we have reported seem to us to illustrate a phase in the activity of the thyroid that we have never previously encountered clinically

As early as 1867 Dumontpallier<sup>4</sup> called attention to the association of exophthalmic goiter with diabetes mellitus, and at that time expressed the opinion that this was not an accidental finding, but that a certain relationship may exist between the two Since that time the association of these two diseases has been adequately confirmed by a number of authors, and various statistics as to its frequency have been quoted These reports have differed markedly, and at times have appeared inconstant because of the failure to differentiate between true diabetes mellitus and the glycosuria that is seen so often in toxic thyroid disease Recently, however, in a series of 25 cases of exophthalmic goiter, Anderson<sup>5</sup> has made a very comprehensive study of the subject By the use of a special technic he was able "to demonstrate the presence of spontaneous glycosuria in every one (100 per cent)" of the 25 cases All of these patients were on an "ordinary" diet Likewise, in all of these patients he was able to show that after the ingestion of 70 grams of glucose, blood sugar determinations at ten minute intervals showed a higher and more protracted curve than that seen in normal individuals In other reports glycosuria is not quite so frequent John<sup>6</sup> found fasting glycosuria in only 19 per cent of the cases of hyperthyroidism Joslin and Lahey<sup>7</sup> found the incidence somewhat greater This subject was reviewed by Fitz<sup>8</sup> in 1921 and more recently by Andersen<sup>9</sup> in a detailed monograph The incidence of hyperglycemia in hyperthyroidism, while generally showing a definite increase, likewise shows a marked variation A number of reports on this aspect of the subject have been tabulated by John<sup>12</sup>

Further evidence of this apparent lowering of carbohydrate tolerance by excessive thyroid function can be seen in the tendency of true diabetics to become worse following the development of toxic goiter The reverse is true following thyroidectomy in these patients While recognizing the difficulty in accurately estimating the amount of carbohydrate tolerance gained in diabetics with toxic thyroid disease after thyroidectomy, Joslin estimates it as "not far from 30 grams"<sup>10</sup> This type of improvement has been recognized and

reported on by a number of other investigators including Fitz,<sup>8</sup> Wilde<sup>11</sup> and John. Similarly there is a tendency toward a lowered blood sugar in hypothyroidism, although in many instances clinical reports have been controversial, probably due to the interrelationship of other endocrine glands. Led by the observation that some diabetics seem to be improved following the development of myxedema, Wilde, Foster and Pemberton<sup>13</sup> have described a case of severe diabetes without evidence of hyperthyroidism upon whom a total thyroidectomy was performed with the production of hypothyroidism and a definite increase in sugar tolerance. This increase in tolerance seemed to parallel the decrease in metabolic rate. However, because of the unpleasant symptoms resulting from the myxedema, Wilde and his associates hesitated to recommend the procedure as a routine treatment. Shortly after their report a similar case was recorded by Rudy, Blumgart and Berlin,<sup>14</sup> in which a marked improvement in carbohydrate tolerance was noted following the total ablation of a normal thyroid gland in a severe diabetic. They were able to control the unpleasant symptoms of myxedema by small doses of thyroid extract, and are of the opinion that the procedure can be recommended in "the rare case with very severe diabetes which cannot be controlled adequately by the application of all known therapeutic measures."

From a study of the above clinical reports and others of the same type it seems justifiable to conclude that in patients with hyperfunction and hypofunction of the thyroid gland there is clinical evidence of alteration of the tolerance to glucose in the body.

Experimentally, the evidence is even more conclusive. As early as 1904 Lorand<sup>15</sup> reported that ten days after thyroidectomy in dogs made diabetic by previous pancreatectomy there was a disappearance of the glycosuria. This experiment was repeated by Eppinger, Falta and Rudinger<sup>16</sup> and subsequently by W. G. MacCallum<sup>17</sup> with results of a similar nature but not so striking. They were able to obtain a diminution of the glycosuria, but not a complete disappearance. More recently, however, Yriat<sup>27</sup> has failed to confirm such findings. In an effort to explain this phenomenon the first important contribution was that by Cramer and Krause<sup>18</sup> who, in 1913, showed that the feeding of thyroid substance to cats and rats resulted in a diminution in the amount of glycogen in the liver. This finding has been confirmed by others on numerous occasions. Lichtman<sup>19</sup> has used it as a basis of explaining the occasional clinical evidence of hepatic disease in severe cases of hyperthyroidism. By the use of a functional test based on the ability of the liver to oxidize cinchophen he was able to show a disturbance in function in 16 of 20 cases of uncomplicated hyperthyroidism. "There was no apparent relationship between the degree of functional impairment of the liver and the basal metabolic rate, the known duration of the disease or the percentage of weight lost. The constancy of depletion of glycogen in the liver cells in animals that have been fed thyroid substance, and probably in clinical thyrotoxicosis suggests that the disturbance in oxidation of cinchophen is related to the capacity of the cells to store and mobilize glycogen." Youmans

and Wai field,<sup>20</sup> using the phenoltetrachlorophthalein test, found an impairment of hepatic function in 50 per cent of their cases and concluded that "it is probable therefore that a change in thyroid activity in thyrotoxicosis may result in a glycogen free or poor liver, more susceptible to damage by some toxic agent present in this disease or more susceptible to injury by the disturbed thyroid function itself" In an extensive study of the morphologic changes in the liver in Graves' disease, Weller<sup>21</sup> was able to show definite damage in 54 per cent of a group of selected cases, while in a matched control series the frequency was only 2 per cent A similar study by Beaver and Pemberton<sup>22</sup> describes three predominant types of hepatic lesions in exophthalmic goiter (1) acute degenerative lesions, (2) simple atrophy, and (3) subacute toxic atrophy and toxic cirrhosis

Burn and Maiks,<sup>23</sup> in 1925, while studying the relation of the thyroid gland to the action of insulin, noted that "the presence of large amounts of thyroid hormone in the circulation enables the organism to prevent the occurrence of severe hypoglycemia in spite of the injection of relatively large doses of insulin" This observation was found to be true until the liver had been depleted completely of available glycogen and was thought to be explained by the action of the thyroid in stimulating glycogenesis Recently, Goldblatt<sup>24</sup> has observed that in many instances when an apparent sensitivity to insulin has existed, the underlying factor has been an inability on the part of the organism to mobilize sugar readily from the liver to replenish the falling level in the blood stream Such an explanation would suffice in the insulin sensitivity seen following removal of the adrenals In the recent work of Cope and Maiks,<sup>25</sup> a similar explanation of the insulin sensitivity following hypophysectomy may be given These workers have developed the conception that the effect of adrenalin on glycogenolysis depends upon the presence of the anterior lobe of the hypophysis Through hormonal secretion this structure apparently possesses the ability to mobilize liver glycogen, and is stimulated to do so by the presence of adrenalin Without the presence of the anterior lobe of the hypophysis, adrenalin loses its ability to free the liver of sugar, and the reaction to a small dose of insulin becomes much more marked

The presence of an increased sensitivity to insulin in myxedema and in the thyroidectomized animal has been known to exist for a long time Goldblatt has shown that the response to adrenalin in the thyroidectomized animal is both slower in onset and less in degree in so far as the blood sugar determinations are concerned He is of the opinion that lack of thyroid secretion produces a "failure to initiate adequate glycogenolysis at the hypoglycemic blood sugar levels" and that this is due to "the sluggishness of response of the sympathetic mechanism responsible for glycogenolysis in the liver"

From the above studies, therefore, it seems apparent that the thyroid secretion is capable of elevating the level of sugar in the blood with the potential production of glycosuria It depletes the liver of glycogen and tends to make the body more resistant to the action of insulin While these effects

may be due partly to the increase in the utilization of glucose caused by an increase in the amount of oxidation in the body, they probably are best explained by the marked effect of the thyroid secretion in producing more rapid glycogenolysis. Such an action as has been shown on repeated occasions occurs quite dramatically when the adrenal-sympathetic mechanism is stimulated. With the presence of a similar function in the thyroid gland we are apparently dealing with a balanced physiologic synergy in which three different structures act toward the same end, enhancing the action of each other. They all tend to elevate the blood sugar level. Such a statement, however, should not be construed to mean that these structures do not likewise exert an action independent of each other.

DISCUSSION—While differing in degree, it is apparent that the thyroid, as well as the adrenal-sympathetic system, acts in effecting the mobilization of glycogen from the liver. It is only by the utilization of such a complex mechanism that the organism is able to preserve the blood sugar at the constant level obviously necessary in the economy of the body. During phases of acute hypoglycemia, occurring spontaneously or induced by insulin, the most important factor in restoring the sugar to the normal level in all probability is the adrenal gland. Certainly there is considerable experimental and clinical evidence in support of this. However, it seems reasonable to believe that if for some reason this mechanism were altered so that the adrenal action was insufficient, the thyroid gland might compensate by increasing its functional activity. The two cases described above suggest that this is true. If the evidence of increased thyroid activity noted in the first case were of a compensatory nature, we cannot help but feel that thyroidectomy would only tend to aggravate the symptoms of hypoglycemia. It is for this reason that pancreatic resection was advised. It is only fair to state that in our opinion such a situation is rare. Certainly, in our experience, this is the first patient that we have encountered with a blood sugar consistently low and severe enough to produce symptoms associated with a toxic goiter. However, we do wish to emphasize one thing. The presence of a goiter and signs of hyperthyroidism are not necessarily indications for thyroidectomy until detailed study offers evidence that this is the best treatment. Until this is done the clinician can hope to contribute but little to the solution of the problem of Graves' disease.

#### CONCLUSIONS

- (1) Evidence of the effect of the thyroid gland on carbohydrate metabolism is briefly reviewed.
- (2) The action of the thyroid secretion in mobilization of sugar from the liver is considered in detail.
- (3) Evidence is brought forward to show that because of this action the thyroid gland may undergo compensatory hyperactivity in occasional hypoglycemic states in an effort to elevate the level of sugar in the blood.
- (4) Two cases are presented, one of which shows clinical evidence and

the other morphologic evidence of such compensatory hyperactivity of the thyroid. In the first case the presence of the classical features of Graves' disease was noted.

(5) In one of these cases an apparent toxic goiter disappeared following the relief of the hypoglycemia after partial resection of the pancreas.

## REFERENCES

- <sup>1</sup> Loeb, Leo, and Bassett, R. B. *Proc Soc Exper Biol & Med*, 26, 860, 1929
- <sup>2</sup> Cole, W. H., and Womack, N. A. *J A M A*, 90, 1274, 1928
- <sup>3</sup> Cole, W. H., Womack, N. A., and Ellet, M. *Arch Surg*, 22, 926, 1931
- <sup>4</sup> Dumontpallier. *Compt rend Soc de biol*, 19, 116, 1867
- <sup>5</sup> Anderson, W. T. *Acta med Scandinav* 78, 229, 1932
- <sup>6</sup> John, H. F. *J A M A*, 99, 620, 1932
- <sup>7</sup> Joslin and Lahey. *Am J M Sc*, 176, 1, 1928
- <sup>8</sup> Fitz. *Arch Int Med*, 27, 305, 1921
- <sup>9</sup> Andersen, W. T. *Studies on Blood Sugar and Glycosuria in Exophthalmic Goiter*. Levin and Munksgaard, Copenhagen, 1933
- <sup>10</sup> Joslin. *Treatment of Diabetes Mellitus*. Lea and Febiger, Philadelphia, 1935
- <sup>11</sup> Wilder, R. M. *Arch Int Med*, 38, 736, 1926
- <sup>12</sup> John, H. F. *Endocrinology*, 11, 497, 1927
- <sup>13</sup> Wilder, R. M., Foster, R. F., and Pemberton, J. de J. *Proc Staff Meet, Mayo Clin* 8, 720, 1933
- <sup>14</sup> Rudy, A., Blumgart, H. L., and Berlin, D. D. *Am J M Sc*, 190, No 1, 51, 1935
- <sup>15</sup> Lorand, A. *Compt rend Soc de biol*, 56, 488, 1904
- <sup>16</sup> Eppinger, H. W., Falta and Rudinger, C. *Ztschr f klin Med*, 66, 1, 1908
- <sup>17</sup> MacCallum, W. G. *Bull Johns Hopkins Hosp*, 20, 265, 1909
- <sup>18</sup> Cramer and Krause. *Proc Royal Soc, Series B*, 86, 550, 1913
- <sup>19</sup> Lichtman, S. S. *Arch Int Med*, 50, 721, 1932
- <sup>20</sup> Youmans, J. B., and Warfield, L. M. *Arch Int Med*, 37, 1, 1926
- <sup>21</sup> Weller, C. V. *Ann Int Med*, 7, 543, 1933
- <sup>22</sup> Beaver, D. C., and Pemberton, J. de J. *Ann Int Med*, 7, 687, 1933
- <sup>23</sup> Burn, J. H., and Marks, H. P. *J Physiol* 60, 131, 1925
- <sup>24</sup> Goldblatt, M. W. *J Physiol*, 86, 46, 1936
- <sup>25</sup> Cope, O., and Marks, H. P. *J Physiol* 83, 157, 1934
- <sup>26</sup> Aitken, L. F. Personal communication
- <sup>27</sup> Yriat, M. *Compt rend Soc de biol*, 105, 128, 1930



# THE VARIATIONS OF BLOOD AMYLASE DURING ACUTE TRANSIENT DISEASE OF THE PANCREAS

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A SERIES of observations is recorded on patients suffering severe, but transient, attacks of acute epigastric pain during which the blood was studied for its content of amylase, a starch-splitting ferment which is present in the pancreatic juice, circulating blood, and elsewhere. The findings seemed to indicate such a definite relationship between the alterations in the blood amylase and the condition of the pancreas as to be of considerable diagnostic value. Since disease of the pancreas is so difficult to detect on clinical examination alone, the importance of blood amylase determinations is obvious.

PREVIOUS OBSERVATIONS—In previous papers<sup>1, 2</sup> from this clinic the value of blood amylase determinations in the detection of acute pancreatic disease was discussed. However, only single determinations of the ferment were made, this, indeed, is true of nearly all of the clinical studies which one finds in the literature. The repeated measurement, day after day, as the clinical manifestations change has not been made. In recent years, particularly, but few clinical studies of blood amylase have been recorded. Acute pancreatic necrosis is such a rare condition that surgeons have perhaps not been impressed with the necessity of a laboratory test for its recognition. In other studies from this clinic<sup>3, 4</sup> however, it was suggested that acute pancreatitis without necrosis, and of a transient nature, was perhaps a frequent condition, often masquerading as biliary colic, peptic ulcer or intestinal obstruction. If so, blood amylase determinations should be made more frequently. It is of special interest to note that E. A. Graham,<sup>5</sup> over ten years ago, stated "Is it not probable that many cases of severe epigastric pain of uncertain nature which clear up spontaneously are of this origin?" (i.e., acute pancreatitis). A recent publication by Comfort,<sup>6</sup> from the Mayo Clinic, has also indicated the probable frequency of acute pancreatic disease, instead of blood amylase this observer measured blood lipase, a ferment also present in the pancreatic juice. He found that there was an increased lipase content of the blood in 17 of 20 patients in whom the clinical and pathologic data pointed to an acute process. The blood was examined within ten days after the onset of the acute attack of the upper abdominal disease or during a period of persisting symptoms. In each case the surgeon reported the presence of pancreatic disease at subsequent operation.

The origin of the starch-splitting ferment, amylase found in the blood, has been the subject of much dispute, although, as already pointed out,<sup>1</sup> the bulk of

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the evidence indicates that it is of pancreatic origin, in large part at least. The question has more than theoretical interest in so far as it concerns the significance of changes in blood amylase in relation to the presence or absence of pancreatic disease. Doubtless the final answer to the question of the origin of blood amylase will be made after further experimental study. For the present, observations recorded herein will be concerned only with the practical and diagnostic, not with the etiologic correlation, of blood amylase and the pancreas.

*Method*—A discussion of the various methods for the measurement of amylase may be found elsewhere.<sup>1</sup> In general, three main types of procedure are available for the detection of this enzyme. The oldest is based on the disappearance of starch in suspension as shown by the starch-iodine test, this method has been popularized by Wohlgemuth. The second procedure is based on the measurement of the glucose produced by the ferment acting on starch, called conveniently the sugar reduction method. The third or viscosimetric technic depends upon the reduction in the viscosity of a colloidal starch solution as digestion proceeds.

In the present study blood amylase was studied by one or the other of all three methods. The values found were so high that the differences in method played no rôle in the findings. While the viscosimetric method, as reported in previous papers is probably the most accurate, it requires more care and equipment than is essential in measuring the high values herein reported. For detecting high concentrations of amylase, therefore, any of the three methods suffice and indeed the simplest is most advisable. Undoubtedly the sugar reduction technic is best adapted for use in most clinical laboratories. Descriptions of the various methods will be found in text-books on clinical laboratory technic. A modified sugar reduction method which is used in many Saint Louis hospitals has been devised by Dr. Michael Somogyi and is carried out as follows:

A colloidal suspension of 1½ per cent washed (C P) corn starch is prepared as a starch solution, which if sterile keeps fairly well, the formation of molds makes it unsuitable. To 5 cc of this suspension, 1 cc of the patient's plasma or serum and 2 cc of 1 per cent sodium chloride is added, and the mixture incubated for 30 minutes at 40° C. Then 1 cc of 5 per cent CuSO<sub>4</sub> is added immediately, the mixture is shaken and 1 cc of 7 per cent sodium tungstate is added, the mixture is again shaken and filtered. Sugar determination is made on 5 cc of the filtrate. From the total amount of sugar formed by the hydrolysis of the starch, is subtracted the amount of sugar present in 1 cc of the patient's serum. The result is expressed in milligrams of sugar per 100 cc of blood. Normally 70 to 200 milligrams of sugar will be produced by 100 cc of blood serum in this way. At the height of an acute pancreatic obstruction or inflammation this value may reach a figure as high as 3,000 mg (i.e., mg per 100 cc of blood).

COMMENT—Eight cases are recorded of patients suffering acute epigastric pain of short duration, during which the blood amylase, extremely high during the height of symptoms, gradually returned to normal with the subsidence of the attack. The main clinical findings are summarized in Table I. The blood

# BLOOD AMYLASE IN PANCREATITIS

amylase values of seven of the cases are represented in Chart 1, and of the eighth case in Chart 2

TABLE I

Patient	Sex, Age	Duration of Attack (days)	Cholecystogram	Jaundice	Clinical Diagnosis	Remarks
No 1	F 29	3	Faint shadow	++	Biliary colic	Refused operation, many similar pre- vious attacks High dye reten- tion
No 2	F 35	3	No shadow	+	Biliary colic	Cholecystectomy 3 days after attack Fat necrosis of pancreas (Bi- opsy)
No 3	F 32	3	No shadow	+	Acute in- terstitial pancrea- titis	Recurrent attack cholecystectomy 2 mos previously
No 4	F 43	2	No shadow	+++	Ruptured peptic ulcer	Cholecystectomy 14 days after at- tack, stone, bi- opsy of pancreas normal, head of pancreas in- durated
No 5	F 34	4	Normal	+	Biliary colic	Cholecystectomy 1 wk after attack Chronic inflamed gallbladder con- taining stones, firm pancreas by palpation
No 6	F 28	2	Good shadow with several nonopaque stones	0	Biliary colic	Cholecystectomy 1 wk after attack, pancreas firm to palpation
No 7	M 37	3	Faint shadow (subsequently normal)	0	Intestinal obstruc- tion	Similar attacks pre- viously, local ten- derness over pan- creas, no opera- tion
No 8	F 42	1	Not taken	++	Coronary disease	History of repeated attacks diagnosed biliary colic Chronically in- flamed gall- bladder with stones removed before present at- tack (see chart 2)

The correlation between the clinical behavior of the patients and the content of amylase in the blood was striking. In four cases a laparotomy was performed after the attack had subsided. In all of them the pancreas was palpated and found to be firm and indurated. In each patient a diseased gall-bladder containing stones was found and removed. In one of them operation was performed three days after the attack, and the pancreas was inspected and found to contain areas of fat necrosis about it and a biopsy revealed interstitial pancreatitis. Biopsy of the pancreas in another patient revealed no microscopic change even though the gland felt hard and indurated, operation, however, was performed two weeks after the attack had subsided. In the remaining four patients the evidence of pancreatic disease was based on the high amylase values, although all had similar clinical manifestations of severe epigastric pain,

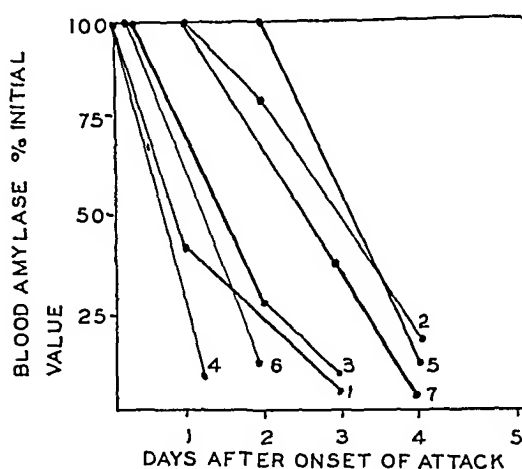


CHART 1—Composite graph of blood amylase values in seven cases of transient epigastric pain, etc (see Table 1)

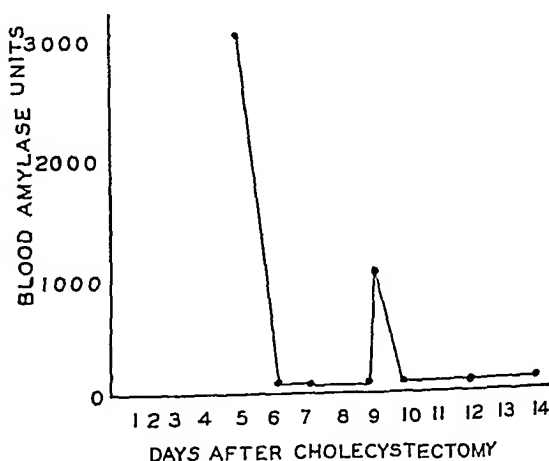


CHART 2—Graph of blood amylase values in case 8 (Table 1). The two attacks on the sixth and ninth postoperative days simulated coronary disease.

nausea, vomiting, etc. Of the four cases, however, two had already had a cholecystectomy, they represented therefore examples of recurrent pain.

Although the number of cases is small, the evidence presented suggests that acute pancreatic disease may prove to be the cause of many attacks of upper abdominal pain which have hitherto been usually diagnosed as biliary colic, but in certain instances perforated ulcer, intestinal obstruction or coronary disease. The behavior of the blood amylase in these cases is striking and certainly warrants the use of this test in patients with manifestations of acute upper abdominal disease. Further study will undoubtedly reveal the nature of the pancreatic lesion which probably accounts for the rise and fall of the blood amylase. Previous reports have recorded the existence of many instances similar, clinically, to the present cases, in which the presence of acute interstitial pancreatitis was described. Fat necrosis in the region of the pancreas was also noted in some of these cases. It may be, however, that in certain instances the lesion responsible for the rise and fall of blood amylase is merely a transient obstruction to the main pancreatic duct, actual parenchymatous inflammation may not be necessary to explain the clinical and laboratory findings. Indeed, unless the pancreas is observed at the time of acute symptoms,

no abnormality may be expected if the lesion is of a transient nature. This may be the explanation of the normal findings in the biopsy of the pancreas in Case 4. On the other hand, the disease may be confined to the head of the pancreas, biopsy of other portions of the gland may thus be normal. The localization of the inflammation to the head of the pancreas is suggested by its frequency, as observed by a great many surgeons. Experimental evidence has repeatedly shown how rapidly, and how extensively, blood amylase will rise after the production of pancreatic disease, particularly duct obstruction. Recent studies of this type have been reported by Clasen, Johnstone and Orr<sup>7</sup> and by McCaughan<sup>8</sup>. However, there is no evidence that increases in blood amylase ever occur except when pancreatic disease is present.

It is suggested, as a fruitful source of further study, that when possible estimations of blood amylase at frequent intervals be made on all patients with severe, acute, upper abdominal pain from the very onset of the attack. When operations are performed upon such patients, particularly those with biliary disease, the pancreas should not only be palpated in order to detect enlargement and induration but also inspected particularly for the existence of fat necrosis. In many patients operated upon within a week or two of the attack the latter finding may be expected inasmuch as it takes some time for the evidences of fat necrosis to disappear. Biopsy, finally, of the pancreas, particularly when induration and swelling is present, will often reveal objective data as to the nature of the lesion, provided, however, operation is carried out during or within a day or two after the attack. The probable frequency of hitherto unsuspected pancreatic disease capable of producing severe symptoms will thus be established. The practical importance of such observations concerns, in part, the problem of recurrent pain after cholecystectomy, such a distressing sequela to operation is often due to pancreatic disease<sup>4</sup>. Case 3 in the present series represents such an instance.

It should be emphasized that the present findings are not concerned with acute pancreatic necrosis, a disease which behaves quite differently. While this lesion is accompanied by elevation of the blood amylase it rarely, if ever, subsides spontaneously, in most instances the progress of the patient is steadily downward. When the patient is suffering from pancreatic necrosis the existence of serious manifestations of circulatory impairment, such as low blood pressure, rapid thready pulse, and cyanosis are sufficiently characteristic to differentiate the disease from simple subsiding pancreatitis. The blood amylase in two cases of pancreatic necrosis was recently studied, and in them a very high value was found which decreased slowly reaching a subnormal level just before death. Operation had not been performed in either case. At autopsy the pancreas, in each instance, was found to be completely destroyed, thus accounting for the fall of blood amylase. The significance of the fall of blood amylase in such a case is obviously quite different from those described in detail above. It is clear, therefore, that while a high amylase points to the existence of serious pancreatic disease the decision as to operation based on the presence or absence of pancreatic necrosis must be made on other grounds.

From the evidence now available one may only say that the blood amylase reflects the existence of, but does not reveal, the nature of a pancreatic lesion. On the other hand, the finding of a normal blood amylase is a valuable means of excluding the pancreas as a cause of acute epigastric pain. Two such instances were recently observed by the author. In one, operation was performed and revealed an acutely inflamed appendix lying in the epigastrium attached to the falciform ligament. In the other, operation was not performed, coronary thrombosis was the final diagnosis, as revealed with the electrocardiogram and the subsequent clinical behavior of the patient.

SUMMARY —(1) A number of patients were studied suffering from transient attacks of acute upper abdominal pain with nausea, vomiting and latent jaundice, in whom a clinical diagnosis of biliary colic, perforated ulcer, intestinal obstruction or coronary disease had been made.

(2) In each instance a very high concentration of blood amylase was found, when examined at the height of the attack, but which gradually returned to normal with the subsidence of symptoms.

(3) Anatomic evidence of disease of the pancreas was found in each instance coming to operation. The nature of the pancreatic lesion has been discussed.

#### REFERENCES

- <sup>1</sup> Elman, R., Arneson, A. N., and Graham, E. A. Value of Blood Amylase in the Diagnosis of Pancreatic Disease. *Arch Surg*, 19, 943, 1929.
- <sup>2</sup> Elman, R. Blood Amylase in Relation to Disease of the Pancreas. Further Observations. *Arch Int Med*, 48, 828, 1931.
- <sup>3</sup> Elman, R. Acute Interstitial Pancreatitis. *Surg, Gynec, and Obst*, 57, 291, 1933.
- <sup>4</sup> Elman, R. Acute Inflammation of the Pancreas. *Surg, Gynec, and Obst*, 61, 670, 1935.
- <sup>5</sup> Graham, E. A. Acute Pancreatitis. *Surg Clinics N Amer*, 5, 1387, 1925.
- <sup>6</sup> Comfort, M. W. Serum Lipase, Its Diagnostic Value. *Proc Staff Meetings Mayo Clinic*, 10, 810, 1935.
- <sup>7</sup> Clasen, A. C., Johnstone, P. N., and Orr, T. G. Blood Amylase in Experimental Pancreatitis. *Surg, Gynec, and Obst*, 59, 756, 1934.
- <sup>8</sup> McCaughan, J. M. Value of Amylase of Blood, *etc*. *Surg, Gynec, and Obst*, 59, 598, 1934.

# THE VALUE OF PREOPERATIVE IRRADIATION IN TUMOR OF THE TESTIS

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WHENEVER there occurs, in the current medical literature, an unusual increase in the number of papers dealing with a given subject, one can feel measurably sure that either a new diagnostic method has been evolved, or that some new advance in therapy has become available, or perhaps someone has rudely awakened us to the realization of an unsuspected morbidity or, worse yet, mortality

During the past 10 years 115 articles have appeared on the subject of testicular tumor, and two-thirds of these (76) have been published in the past five years When we look for reasons, we find

First Tanner's report of 600 collected cases, nearly all treated by orchidectomy, 425 of which were followed, who states that after four years only 25 were well—cure, 53 per cent, mortality, 94.7 per cent Hinman says, "Orchidectomy, even with early diagnosis, is a dismal failure", and because of a mortality so appalling, he developed his radical operation, showing a definite, but hardly a satisfactory, improvement in the prognosis

Second The field of diagnosis has been greatly broadened and markedly improved since the demonstration of a gonadotrophic hormone in the urine when a tumor or its metastases are present in the body With this there arrived not only an accuracy of diagnosis, but also a test that has been rapidly developed into an appreciable index of the type of malignant cell present, and its sensitivity to irradiation

Third There has come an advance in therapy by the addition of irradiation to surgery to such an extent that, as Keyes says, "Without irradiation prognosis is utterly bad "

We are anxious, therefore, to bring to your attention the evidence we have that makes us feel that irradiation should precede surgery, but that it should never supplant it entirely This idea naturally followed the results obtained in kidney tumors in children, in which cases we pointed out the distinct advantage of preoperative irradiation In testicular tumor the surgical procedure is rarely as difficult as in the case of renal neoplasm, but the clinicopathologic reasons remain the same

Zondek, in 1929, first observed the appearance of a gonadotrophic hormone in the urine of a man suffering from a teratoma of the testis, and, three years later (1932), reported his observations on the use of this test in the diagnosis of teratomata in 14 cases The test itself has been materially improved and refined, until today it stands, not only as a qualitative test, but as a quantitative one also It is calculated in established mouse units the

titer of hormonal excretion, and this, in turn, can be applied as an index of both the type of tumor and its radiosensitivity. The feeling is growing that all testicular tumors are basically teratomatous in origin and that practically all exhibit some type of carcinomatous proliferation, while the characteristic round cell tumor, so frequently called a sarcoma in the past, is now the seminoma of Chevassu and arises from the adult germinal cells of the seminiferous tubules. One-sided overgrowth is the rule rather than the exception in all testicular tumors, so that frequently a tumor can be given rather definite characterizing features, though, as Ewing has pointed out, serial section of the whole tumor may be required to establish a positive opinion of a single cell type.

Ferguson has pointed out that the titer of the gonadotrophic hormone, Prolan A, is a rather specific index of the dominant type of tumor cell present, and that the mouse unit readings in the different groups overlap so little that it is possible to make a tentative diagnosis of the predominant cell type on this determination alone. The observation has also been made that, after irradiation of the primary tumor or its metastases, a prompt drop in the excretion titer of Prolan A in the urine is evidence of cell sensitivity, the rapidity, and extent of decrease, being excellent indices upon which to base a prognosis.

We have postulated the following acceptable facts to guide our surgery, bearing in mind that the clinical result is of greater interest than an academic discussion of tumor types.

First. The younger the cell, the greater its roentgen sensitivity.

Second. The younger the dominant cell type, the more frequent and the earlier the metastases.

Third. In the face of existent metastases, irradiation should, of course, precede the orchidectomy.

Fourth. If this last be true in gross visible metastases, it should be even more essential if metastatic involvement is just beginning.

Based on these assumptions, therefore, it has been our practice for the past three years to

First. Have a Wassermann and a Prolan A determination.

Second. Begin immediately the administration of deep roentgen therapy.

Third. Perform an orchidectomy at any interval up to five weeks after the last roentgen ray treatment.

In considering the preoperative roentgen therapy, Doctor Pendergrass has felt that too heavy irradiation over the primary tumor may be actually traumatic and provocative of cell dispersion, just as one may traumatize a lesion in performing a biopsy. He has obtained the impression that in epidermoid carcinoma of the lip a violent local reaction is apt to occasion an adenopathy in excess of a simple reactionary lymphangitis, in fact, some of these nodes have been proven to be malignant, and these observations have been made in patients who did not have palpable nodes prior to irradiation. The approach, therefore, is from the periphery, converging toward the focus of the disease, and in testicular tumor irradiation includes the lymphatic channels from the



chin to the tube ischiu anteriorly and posteriorly, it being hoped, thereby, to destroy metastatic foci of any size, to create a field resistant to malignant cell implantation, and, finally, to administer daily to the immediate lymph drainage radicals and the local tumor, a small, protracted dose, up to the limit of skin tolerance, keeping in mind the general resistance of the patient, as determined by biweekly blood counts

*Pathologic Considerations*—The mixed tumors of the testicle can be divided into three groups, when they are studied relative to their degree of radiosensitivity

Group I—*The tumors that are made up of undifferentiated anaplastic immature cells* In this group, two different types have been observed One type is made up almost entirely of small round embryonal cells with very little cytoplasm (lymphoid) In the other the predominating cell is somewhat larger but definitely anaplastic (seminoma) The stroma is scant in both, and the vascularity is abundant with vessels in different stages of development

Group II—*In this group may be placed the adult teratomata* The epithelial cells are large, well developed, and differentiation is evidenced throughout the tumor They are in tubular or acinar arrangement Occasionally small areas of imperfectly differentiated cells are seen The vascularity is variable In some fields the vessel development is hemangiomatous Cartilage, bone and calcium are not infrequently seen Dense whorls of fibrous tissue and myxomatous degeneration are usually present

Group III—*This group, like Group II, is very complex, but differs from the previous group by showing a greater diversity in the stages of cellular development* These tumors are made up partially of anaplastic and partially of well differentiated cells In some the embryonal elements predominate, in others the adult teratomatous structures predominate The microscopic findings in this group are characteristic of radiosensitivity and radioresistance The degree of regression from irradiation must apparently be dependent upon the number of anaplastic cells

The gross changes encountered in these tumors after irradiation ranged from little or no regression to a dramatic disappearance of any palpable neoplasm (Fig 1) In attempting to evaluate the microscopic changes after irradiation, these have been divided into three groups first, those which have undergone complete regression, second, those upon which irradiation has had no apparent effect, and finally, those which have undergone partial regression

The histologic findings in the tumors which have undergone complete regression present two totally different pictures In one the tumor was made up of closely packed shadow cells They stained a very light pink with hematoxin and eosin They are imperfectly outlined with the nucleus and cytoplasm undifferentiated The form of the shadow cells which predominate in the tumor is not unlike those seen in the nonirradiated seminoma Scattered in the meshes of these necrotic cell forms an occasional single deeply staining small round cell is seen These appear as active, viable cells which have not been destroyed by irradiation (Fig 2) The blood vessel changes consist of

endarteritis of the small vessels but no evidence of complete obliteration. There is no increase in the connective tissue. In general, the appearance is that of necrotic cells without displacement fibrosis. If the surgical removal had been effected a week later, the tissue would have appeared as though it had undergone cystic necrosis.

In the other type with complete regression, the tumor is represented by displacement fibrosis with hyalinization and remnants of seminiferous tubules. The blood vessels give definite evidence of endarteritis with occasional obliteration. There are no cells, or remnants of cells, to permit identification or even speculation as to the cell of origin (Fig 3). When the sections are compared with those made from irradiated mixed tumors of the kidney, they are identical.



31 41 5 61

FIG 1—Tumor of the testis after regression from irradiation. This tumor before irradiation was the size of an orange. It was not palpable after irradiation.

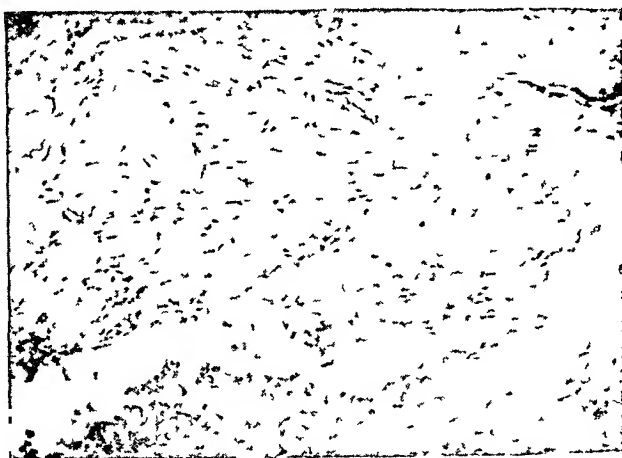


FIG 2—Photomicrograph of a section of the tumor shown in Fig 1. This illustrates the shadow cell type. Small black dots represent remaining viable cells.

with the displacement fibrosis which displaces the small round celled sarcomatous areas.

In the second group are those upon which irradiation had no apparent effect. The microscopic picture is very complex and varied. The epithelial cells of different types are differentiated. The fibrous connective tissue is the mature adult type. In general, the picture is not unlike that described in Group II of the nonirradiated tumors (Fig 4).

In the third group, those which have undergone partial regression, the findings are somewhat variable. Epithelial cells in different stages of development and differentiation are frequently seen. Areas with extensive fibrous changes with collections of shadow cells are evident in scattered fields. The blood vessels in some places show endarteritis while in others they are unchanged. The tumors in this group before irradiation were made up of cells ranging from immature anaplastic lymphoid and epithelial types to the adult well differentiated cell. The former were destroyed, and are represented by shadow cells and fibrosis. The latter, due to their resistance, were not appreciably affected by the irradiation (Fig 5).

In general, the irradiation of testicular tumors has a definite destructive

effect upon the immature embryonal cells, but little or no effect upon the differentiated types. These observations are in keeping with the laws governing cellular radiosensitivity.

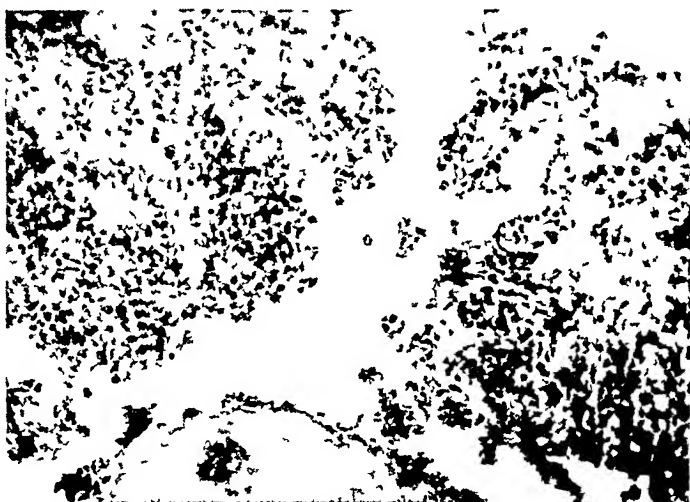
FIG. 3—Photomicrograph of a section of a tumor of the testis, with *complete regression from irradiation*. This illustrates the replacement by fibrous tissue.



FIG. 4—Photomicrograph of a section of an adult teratoma type of tumor of the testis. There is no evidence of regression from irradiation.



FIG. 5—Photomicrograph of a section of a tumor of the testis with *partial regression from irradiation*. This shows large islands of viable cells that have not been destroyed by irradiation.



In view of the foregoing observations it is very evident that, regardless of the degree of clinical improvement, irradiation does not entirely destroy the

neoplasm In that class in which there were occasional viable cells remaining which appeared to have the power of regeneration, it is felt that these tumors should be removed surgically, after the maximum regression from irradiation has been obtained Procrastination after effective irradiation leads to disaster The most favorable time for removal is usually between the fifth and sixth week

### CONCLUSIONS

We have attempted to demonstrate, both from clinical reasoning and from cellular pathology, the advantages to be gained by preoperative irradiation in tumor of the testis Certain points are outstanding and bear accentuation

(1) That orchidectomy alone has given less than 10 per cent of cures, that radical surgery by orchidectomy, with the removal of the entire lymph drainage area, has raised this figure to 19 per cent cured, and that irradiation alone has produced 29 per cent of cures

(2) That if irradiation is to be considered of benefit, its greatest clinical value is to be obtained by its use preoperatively We have presented and discussed the cellular reactions as observed in both irradiated and unirradiated tumors, and find the results in keeping with the laws governing cellular radiosensitivity

(3) That irradiation alone cannot be relied upon to produce a cure because of resistant cells, nor can a cure be appreciated, measured or established by any clinical test Therefore, orchidectomy is mandatory as a secondary procedure

(4) That irradiation should be widespread in its application, and should include the entire body above the primary lesion

It is our conviction that the proper application of these principles will raise the percentage of cures in tumors of the testis well above those at present obtained

DISCUSSION —DR FRANK E ADAIR (New York) stated that there is no phase of modern medicine which so strikingly demonstrates the advance made along the lines of both diagnosis and exact therapy, than in the case of teratoma of the testis, the diagnosis and therapy of which have always been difficult and inexact A few years ago, a new diagnostic aid was given us in the form of a "therapeutic radiation test" Up until this time the diagnosis was based upon a consideration of (1) the findings by palpation which revealed the consistency and the anatomic boundaries of the enlargement, (2) the transillumination test, and (3) the result of the Wassermann test

Now, a most valuable diagnostic addition is given us in the form of a hormone reaction By testing the presence of the Prolan A in amounts above 100 mouse units, we must suspect the presence of a teratoma of the testis if over this amount is found This interesting test goes farther and gives us an idea of the exact histopathology of the tumor The Prolan A test becomes a valuable aid in the periodic follow up of the case It is an easy matter to test the urine of the patient for the presence of excessive amounts of Prolan A It is a sign of the presence of recurrence or metastasis, far more delicate, and more reliable than any clinical or roentgenologic examination

The next great advance in this disease was given by radiation therapy We

are all familiar with the disappointing accomplishments of surgery alone, in this, one of the most malignant of all human tumors. Wasterlain's studies show only 6 per cent of five year cures by orchidectomy alone. Hinman revived the operation of Chevassu, which is one having a high mortality (12.2 per cent), and found but 17 per cent free of disease at the end of five years. Barringer and Dean, of the Memorial Hospital, reported their cases in 1928, and found that by using radiation therapy they had 29.2 per cent free of disease at the end of five years. This encouraging figure was accomplished in spite of the remarkable fact that 89 per cent of the 154 cases reported were inoperable on admission. The greatly increased percentage of cures was obtained by employing the roentgen therapy technic available at that time. Since then, Coutard has developed the fractional dose method of applying radiation which has the double advantage of being able to give larger doses to the tumor and metastatic deposits, and, furthermore, the tolerance of the patient to the treatment is much greater.

To properly treat this disease the radiologist must have a good understanding of its anatomy. Frequently the first complaint of the patient is that of indigestion or a pain in the back. The disease invades the lymphatics and the veins and appears not only in the groin but also at the celiac axis and mediastinum.

At present our treatment consists in preliminary radiation of the testis and surrounding areas including the lower quadrants of the abdomen, the suprapubic area and the inguinal nodes. Approximately six weeks later orchidectomy is performed. Following the operation, the patient is irradiated by the divided dose technic, from the level of the diaphragm down to the trochanters, both anteriorly and posteriorly.

We have divided our teratomata of the testis into five groups:

- (1) The adult type—those possessing cartilage, lung tissue, *etc.* The incidence is about 10 per cent.
- (2) The seminoma—the large cell type. Incidence, 16 per cent.
- (3) The embryonal carcinoma with the lymphoid stroma, very radiosensitive. Incidence, 40 per cent.
- (4) Embryonal adenocarcinoma. Incidence, 33 per cent.
- (5) Chorio-epithelioma. Incidence, 1 per cent.

There is no doubt in my mind but that this newer principle of radiation will add materially to the present five year cure rate of 29.2 per cent. In fact, Ferguson, of our clinic, has already utilized this newer technic, and has obtained freedom from disease in a three year period, of 52.6 per cent.

# SHOCK SYNDROME FOLLOWING SUBCUTANEOUS INJECTION OF BILE OR BILE SALTS

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IN PREVIOUS publications,<sup>1, 2</sup> the writers demonstrated that changes similar to those found in so called secondary shock were found in experimental peritonitis due to bile or bile salts. These changes included a marked fall in blood pressure, a definite hemoconcentration and a reduction in bleeding volume associated with a marked effusion of plasma like exudate into the peritoneal cavity. This fluid loss was considered to be an important lethal factor in the experiments in question, especially since, in many instances, these animals died without evidences of anaerobic infection. On the other hand, the work of Andrews, Rewbridge and Hrdina<sup>3</sup> indicated that death, after the subscapular injection of bile salts, resulted from infection by anaerobic organisms. This apparent difference in the action of bile or bile salts when injected subcutaneously, intramuscularly, or intraperitoneally prompted the present experiments.

Andrews, Thomas and Schlegel<sup>4</sup> found that pieces of liver inserted into the axilla produced death, which was thought to be the result of toxemia. Horrall and Carlson<sup>5</sup> and Horrall<sup>6</sup> found that subcutaneous injection of bile in ten dogs caused more variable results than the intraperitoneal injection. Dogs receiving more than 4 cc per Kg died within 24 hours and some of the dogs receiving as low as 2 cc per Kg died within the same time. There was excessive edema at the site of injection. Dogs receiving less than 2 cc per Kg developed large necrotic sloughs at the site of injection, but usually did not die. Andrews, Rewbridge and Hrdina<sup>3</sup> reported that after injections of sterile 10 per cent bile salt solution or of liver extract under the scapulae of dogs, there resulted in most cases an obvious gas gangrene with positive cultures for anaerobic organisms. In a later paper<sup>7</sup> these authors give protocols of eight experiments in which 10 per cent bile salt solution was injected subcutaneously. All these dogs died within 24 hours, and of six in which cultures were made, all showed *Clostridium welchii* and the site of injection showed gas and induration.

EXPERIMENTAL INVESTIGATION—Group I Eight dogs were anesthetized with morphine and ether during the time of injection. The animals were marked along the midline of the dorsal and ventral surfaces and the injections made subcutaneously into the axilla and groin of one side (the right in five animals, the left in three animals). Two animals received 10 cc of sterile dog gallbladder bile per Kg and the other six received 10 cc of sterile 10 per cent repurified Armour's bile salt solution. Hemoglobin determinations were

made by the Sahli method and with the Van Allen hematocrit, the readings being made before injection and at intervals thereafter until death. All the animals died in from seven to 34 hours, the average being 21 hours. Cultures of the subcutaneous tissues at the site of injection were then taken after iodine sterilization of the overlying skin and incision with a red hot knife. Anaerobic cultures were taken using both swab and tissue block technic. The animals

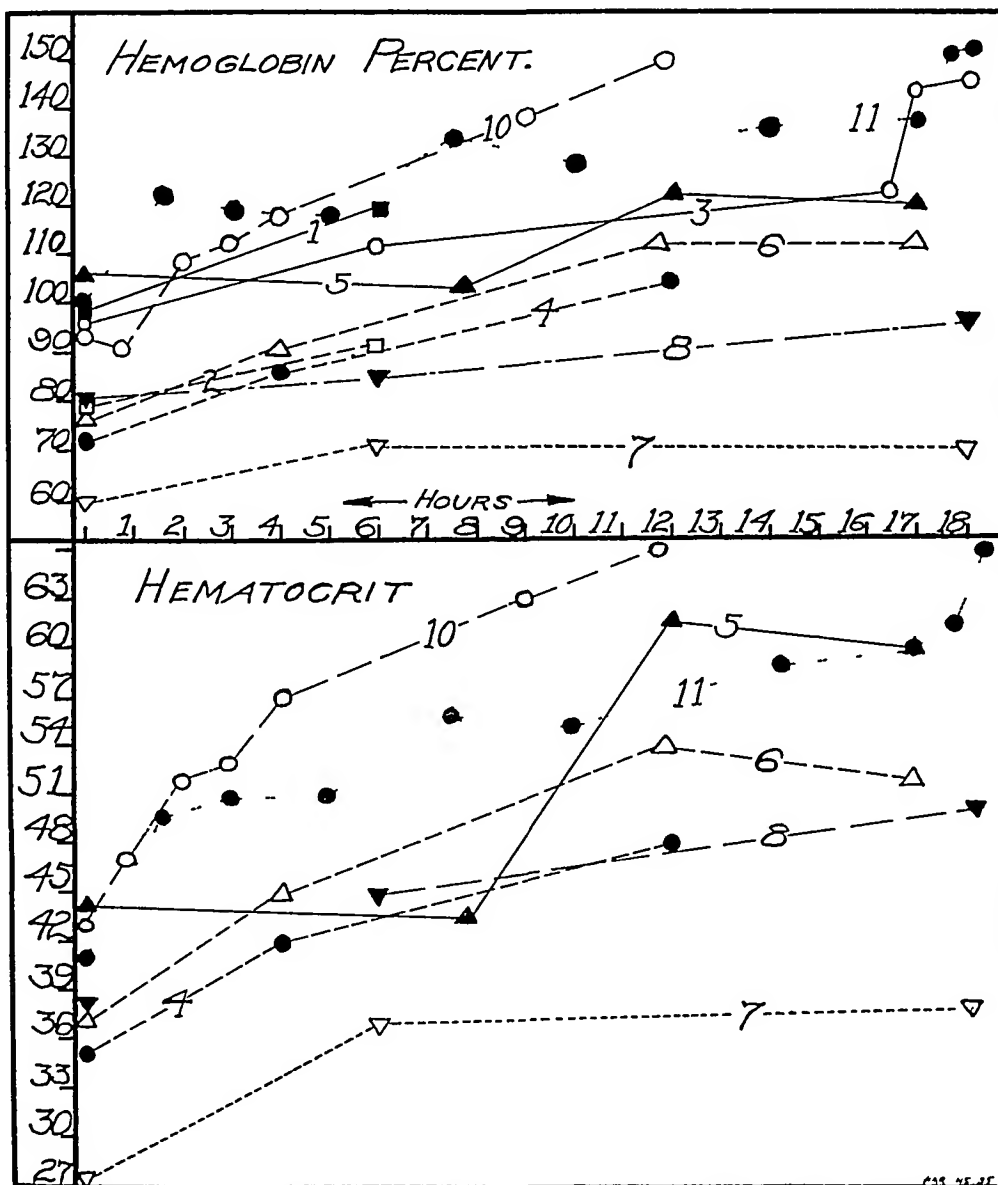


CHART 1—Shows the rise in hemoglobin percentages and hematocrit readings following subcutaneous bile and bile salt injections. The final hemoglobin reading of 53 per cent obtained 29 hours after the injection of bile in Experiment 7 is not included in the chart. The last two values in Experiment 3 were obtained 23 and 28 hours after the injection of bile salts, but are shown in the chart. Similarly the last two results shown at the right in Experiment 11 were obtained 20 and 22 hours respectively after the injection of bile salts.

were then bisected in a manner previously described,<sup>8</sup> and the contralateral halves weighed. The organs were then examined grossly and microscopically. Chemical analyses of the fluid exuded into the tissues at the site of injection were made in three instances by a previously described method.<sup>3</sup>

Group II. Three dogs were thoroughly anesthetized with sodium barbital (250 mg per Kg body weight, intraperitoneally) and were then placed on a

tipping apparatus previously described,<sup>8</sup> after the application of a body case. This apparatus consists of a balanced tray with a connection to a recording marker on a kymographic drum, so that any tipping of the animal to one side or the other can be registered. After a control tracing, the apparatus was steadied and 10 cc of 10 per cent bile salt solution were injected subcutaneously into the axilla and groin on one side. The kymograph tracing then recorded the immediate shift in weight to the injected side due to the weight of the fluid injected and any later shift until the time of death. One of the three animals received an injection on one side of normal saline solution equal in amount to the volume of bile injected on the opposite side, so that there was no immediate shift of weight. In this same experiment there was a continuous recording of the blood pressure until death. This was done by inserting the usual carotid arterial cannula and connecting it with the recording manometer by means of a flexible rubber tube so that interference with the tipping of the apparatus was reduced to a minimum. The cannula was fastened to the midline of the animal so that tipping of the apparatus would not affect the blood pressure base line. Frequent hemoglobin and hematocrit readings were made. At necropsy no cultures or chemical examinations of the fluid forming the local edema were made of these three animals. Bisection and necropsy were performed, however. As a control of the determination made by the bisection method, the difference in weight was observed by counterbalancing the tipping apparatus,<sup>8</sup> only the counterbalancing weights were placed 12 cm from the midline of the apparatus, as this seemed to correspond to the average distance of the center of the edematous area from the midline.

**RESULTS**—The animals all died within 34 hours and all showed a rise in hemoglobin and hematocrit (Chart 1). All animals showed a marked excess in weight of the injected side. This difference in weight in the eight experiments in Group I averaged 3.5 per cent of the body weight (Table I). The three additional animals placed on the tipping apparatus showed a corrected

TABLE I  
THE EFFECT OF INJECTION OF BILE SALTS AND WHOLE BILE SUBCUTANEOUSLY

Experiment	1	2	3	4	5	6	7	8	Average
Dog wgt Kg	8.0	6.0	6.0	8.0	13.0	8.0	5.6	5.2	7.5
Sex	M	F	F	M	M	M	F	F	
Cc bladder bile							56	52	
Cc 10 per cent bile salt sol	80	60	60	80	130	80			
Hours before death	16	7-17	28-34	15	20	20	29	19-29	21
Increase Hb per cent	21	11	50	33	16	36	12	17	25
Increase hematocrit				13	18	17	10	12	14
Wgt injected side*	2,645	1,995	1,817	2,795	4,695	2,685	1,780	1,605	
Wgt normal side	2,195	1,775	1,557	2,500	4,230	2,285	1,440	1,390	
Wgt difference Gm	450	220	260	295	465	400	340	215	
Corrected difference	370	160	200	215	335	320	284	163	
Per cent body weight	4.6	2.7	3.3	2.7	2.6	4.0	5.1	3.1	3.5

\*The weights of the two sides of the animal were determined by Blalock's bisection method. In three experiments (2, 3, and 8) death of the animal occurred some time during the interval listed. In computing the average number of hours before death, the median time is used in these instances.



excess in weight of the injected side of 3.9, 3.8 and 3.9 per cent body weight. The average for the whole series of 11 animals is 3.6 per cent body weight.

*Bacteriologic*—Cultures were made of the edematous tissue at the site of injection in the first eight experiments. In Experiments 4, 5 and 6 these cultures were taken one hour, five minutes and two minutes after death, respectively, and there was no growth. The culture from Experiment 1, taken one hour after death, grew only *Staphylococcus albus* (possibly a contaminant). On the other hand, in Experiments 2, 3, 7 and 8, cultures taken seven hours, three and one-half hours, five minutes, and six hours respectively after death showed no aerobic growth, but in all four instances a large gram-positive anaerobic bacillus grew in the anaerobic media. Since, in all instances, both edematous subcutaneous tissue and muscle were cultured, the organisms found here may be similar to those found by other authors in normal dog muscle.<sup>7</sup> At least, their presence in our experiments was not constant, being found in only one-half of the eight experiments. All but one of these positive results were cultured more than three hours after death. It is quite possible, therefore, that postmortem contamination may account for some of the organisms found. Although at least one-half of the animals died without cultural evidence of anaerobic organisms, all had the fluid shift previously described.

*Pathologic*—Necropsy examination revealed moderate hemorrhage in the adrenal glands especially in the reticular zone and hemorrhage in the mesenteric nodes. There was some blood staining of the bowel contents in two instances, but no petechial hemorrhages in the bowel wall. The most marked change, however, was the extensive edema of the subcutaneous tissue at the site of injection. Sections of the skin, subcutaneous tissue and muscle near the injection were taken in Experiments 9 and 10 and showed extensive edema. Some of the muscle bundles and fibrous tissue showed lack of normal staining reaction with karyorrhexis of the nuclei. In Experiment 10 there were several collections of polymorphonuclear neutrophils. Some of the individual muscle fibers were separated from each other by edema and some of the capillaries were engorged with blood.

*Chemical*—The most striking item of the analysis of the exuded fluid was

TABLE II

CHEMICAL ANALYSIS OF FLUID IN EDEMATOUS TISSUE, PRODUCED BY THE SUBCUTANEOUS INJECTION OF STERILE 10 PER CENT BILE SALT SOLUTION\*

Experiment	NaCl Mg /100 cc	NPN Mg /100 cc	Sugar Mg /100 cc	Total Protein Gm /100 cc
4 Fluid	598	120	0	3.5
5 Fluid	570	125	163	4.6
6 Fluid	593	160	108	4.6
Control Plasma	582	36	109	5.0
Control Plasma	610	29	109	6.2

\*Figures for two normal dogs' blood plasma analyses are given. It is seen that the fluid in the edematous tissue and normal blood plasma are essentially similar except that the nonprotein nitrogen content of the fluid is greater and the total protein content is slightly less.

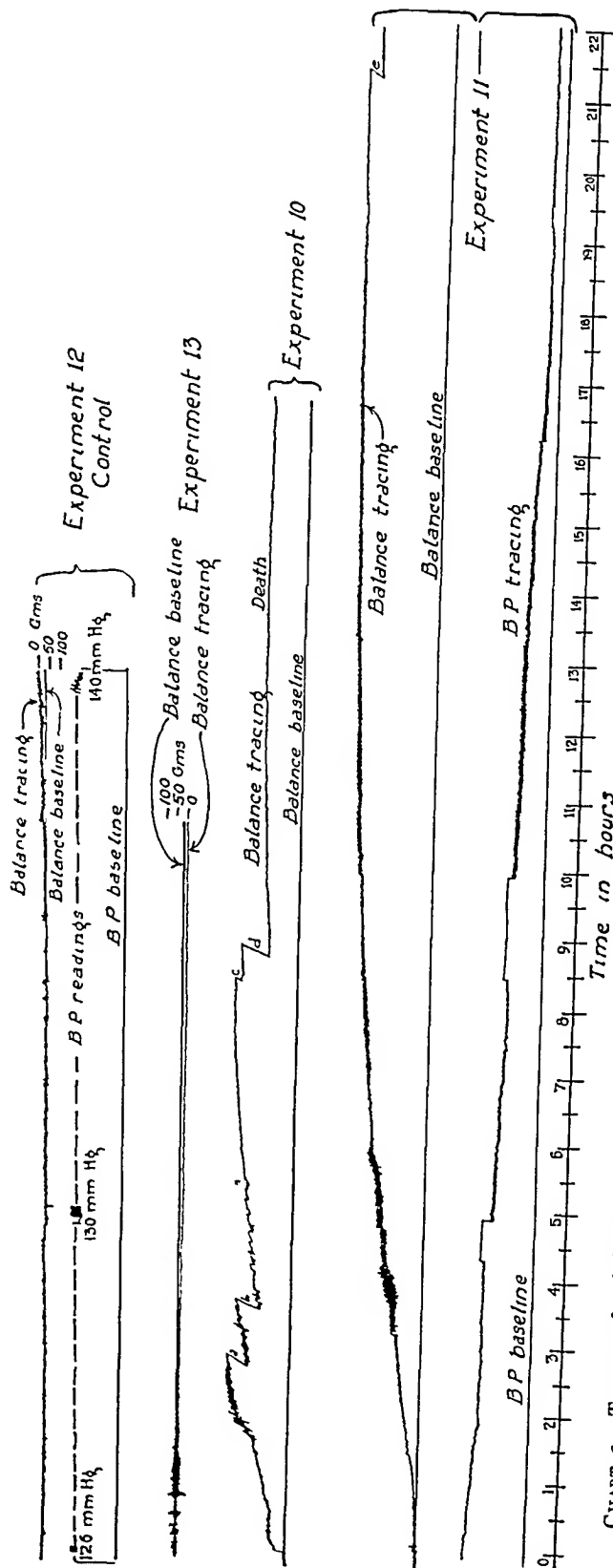


CHART 2.—Tipping of a balanced animal to the side of injection following subcutaneous injection of bile salts

This chart is a composite record of four experiments. In Experiment 12 there are a control balance tracing and control blood pressure tracing. It is seen that there is practically no tipping of the animal even after 14 hours and that the blood pressure remained constant during this interval. Control hemoglobin and hematocrit read 106 and 53, at the end of five hours they were respectively 112 and 50, and at the end of 14 hours were 105 and 51. At the right hand end of the balance tracing the sensitivity of the balance is determined by the counterbalance method with the weights 12 cm from the midline. It is seen that the total shift had amounted to less than 50 Gm. The bisection method gave a difference in weight between the two sides of the animal of 45 Gm (Dog weight = 60 Kg.). In Experiment 13 a control balance tracing is shown. The amount of shift at the end of 11 hours is shown by the counterbalance method to be less than 50 Gm. In Experiment 10 a balance tracing after injection is shown. At the zero hour mark 10 cc of a 10 per cent of bile salt solution were injected into the right axilla and groin with a resultant immediate shift to the injected side because of the weight of 45 Gm were added 12 cm to the left of the midline of the balance. In Experiment 11 a balance tracing and associated blood pressure tracing are shown. At the zero hour mark 10 cc 10 per cent bile salt solution were injected into the right axilla and groin and simultaneously a similar amount of normal saline solution into the left side so that there is no immediate fluid shift. The gradual fluid shift became 50 marked at point *c* that a counterbalance weight of 100 Gm was added 12 cm to the left of the midline of the balance.

that its total protein content averaged about 80 per cent of that of normal blood plasma, that found after burns or freezing is similarly slightly less concentrated than blood plasma in total protein content. The increase in the nonprotein nitrogen content may be in part due to contamination with bile salts.<sup>2</sup> The sodium chloride content was essentially similar to that of blood plasma (Table II)

The three animals that were placed on the tipping apparatus all showed a steady tipping toward the injected side. This tipping seemed to show a relation to the hemoconcentration as represented by the increase in hemoglobin percentage and in the hematocrit readings. In the one experiment in which the blood pressure was measured the tipping and blood pressure fall were somewhat proportionate as seen in Chart 2. Protocols of the three tipping experiments follow

**Experiment 9**—Dog weight 5.4 Kg, 260 mg sodium barbital per Kg. Injection of 60 cc of 10 per cent bile salt solution subcutaneously in right groin and right axilla at 2:40 P. M. Gradual tipping of apparatus in form of decelerating curve until death at about midnight (approximately nine hours after injection). No blood counts. Counterbalance difference in weight of two sides = 200 Gm. Weight right side bisected animal = 1,780 Gm, left side = 1,510 Gm, difference = 270 Gm, or 5.0 per cent body weight by bisection method. This amounts to 3.9 per cent body weight when corrected for the amount of solution injected. Since some of the bile salt solution is probably absorbed, the true value lies somewhere between the weighed and corrected values. Necropsy negative except for bloody fluid in small bowel, an enlarged thyroid gland and extensive edema at the site of injections.

**Experiment 10**—Dog weight 8 Kg, female, 250 mg sodium barbital per Kg. Injection of 80 cc of 10 per cent bile salt solution in right groin and right axilla 2:20 P. M. Gradual tipping in form of decelerating curve until death at 4:20 A. M. (14 hours after injection) (Table III)

TABLE III

Time	Hemoglobin Per Cent	Hematocrit
Control	93	43
2:20 P. M.	injection	
3:00 P. M.	91	47
4:00 P. M.	109	52
5:10 P. M.	112	53
6:30 P. M.	118	57
11:00 P. M.	138	63
1:40 A. M.	150	66
4:20 A. M.	death	

Counterbalance difference in weight of two sides = 360 Gm. Weight right side bisected animal = 2,670 Gm, left side = 2,290, difference = 380 Gm, or 4.8 per cent body weight by bisection method. When corrected for weight of solution injected = 3.8 per cent body weight. Necropsy negative except for slight medullary hemorrhage in both adrenal glands and extensive edema at site of injections.

**Experiment 11**—Dog weight 7 Kg, female, 260 mg sodium barbital per Kg. Injection of 70 cc of 10 per cent bile salt solution in right groin and right axilla and 70 cc normal salt solution into left groin and left axilla at 12:30 P. M. Gradual tipping in form of decelerating curve until death at 12:00 noon next day (23½ hours

after injection) Simultaneous blood pressure tracing, no immediate effect from injection, gradual fall to 28 Mm Hg three minutes before death

TABLE IV

Time	Hemoglobin Per Cent	Hematocrit	Blood Pressure
Control	101	41	170 Mm Hg
12 30 P M	injection		
2 00 P M	122	50	155 Mm Hg
3 45 P M	118	51	128 Mm Hg
5 20 P M	118	51	115 Mm Hg
8 00 P M	133	56	95 Mm Hg
10 30 P M	129	55	87 Mm Hg
2 10 A M	136	59	74 Mm Hg
5 10 A M	138	60	55 Mm Hg
8 00 A M	151	61	40 Mm Hg
10 35 A M	152	66	34 Mm Hg
12 00 M	death		

Counterbalance difference in weight of two sides = 530 Gm Weight right side bisected animal = 2,250 Gm, left side = 1,975 Gm, difference = 275 Gm or 39 per cent body weight by bisection method No correction is applied because of the saline injection on the opposite side Necropsy negative except for extensive edema at site of injections

Control experiments on the changes in blood pressure and blood concentration are detailed by Harkins<sup>9</sup> Two control experiments are shown in Chart 2 In these experiments, animals anesthetized with barbital were placed on the tipping apparatus Simultaneous blood pressure readings in Experiment 12 showed no decrease In neither of the two experiments was there an appreciable tipping of the apparatus

COMMENT—Previous workers<sup>1, 2, 8, 9, 10 to 18</sup> have shown that the loss of whole blood or blood plasma amounting to more than 3 per cent body weight into the tissues or externally, as in hemorrhage, is apt to cause death Such a loss represents almost 50 per cent of the blood volume (calculated as one-thirteenth of the body weight) and corresponds to a hemorrhage of over two liters in a 70 Kg man To be of serious import such a loss must occur in a relatively short time In Blalock's work<sup>11</sup> on burns the animals lost an average of 3.3 per cent body weight of plasma into the tissues after an average of 15 hours In the present series of 11 animals the average loss of similar fluid was 3.5 per cent body weight after an average of 19 hours

The question as to whether the loss of plasma or blood as found in various types of shock by previous workers is sufficient to cause death, or even be a major factor in the death of the experimental animals in question, is not within the province of this paper However, if it is assumed that the physical explanation of shock applies to burns, freezing, intestinal trauma, trauma to an extremity, and simple hemorrhage, then it can equally well be applied to the effects of subcutaneous bile or bile salt injection

Since the subcutaneous injection of bile or bile salts produces an exudation of plasma like fluid similar to that found intraperitoneally in bile peritonitis, the present experiments demonstrate that there is no qualitative difference in

the action of bile depending on the site of action. This refutes one possible objection to the theory that secondary surgical shock is one of the chief lethal factors in bile peritonitis. The action of the bile or bile salts when injected subcutaneously or intraperitoneally is probably that of a local irritant. Anesthesia had to be particularly deep during the time of injection to prevent all evidences of pain. The biliary solutions probably injure the capillaries at the site of injection with a resultant local leakage of protein containing fluid.

#### CONCLUSIONS

(1) The subcutaneous injection of bile or bile salts causes a local exudation of plasma like fluid into the tissues. This fluid amounted in 11 experiments to an average of 3.8 per cent body weight with death 19 hours after injection. There was an accompanying hemoconcentration and blood pressure fall.

(2) This fluid exudation is sufficient in quantity to be a lethal factor of importance.

(3) The parallelism of the action of bile or bile salts when injected subcutaneously and intraperitoneally in producing a shock like syndrome affords reciprocal evidence for the importance of secondary surgical shock as a lethal factor in the two conditions.

#### REFERENCES

- <sup>1</sup> Harkins, H. N., Harmon, P. H., Hudson, J., and Andrews, E. Mechanism of Death in Bile Peritonitis, *Proc Soc Exper Biol & Med*, 32, 691, 1935.
- <sup>2</sup> Harkins, H. N., Harmon, P. H., and Hudson, J. Lethal Factors in Bile Peritonitis. I. Surgical Shock. *Arch Surg*, 33, 576, 1936.
- <sup>3</sup> Andrews, E., Rewbridge, A. G., and Hrdina, L. Causation of *B. Welchii* Infection in Dogs with Sterile Liver Extract and Bile Salts. *Proc Soc Exper Biol & Med*, 28, 136, 1930.
- <sup>4</sup> Andrews, E., Thomas, W. A., and Schlegel, K. Newer Aspects of Liver Disease. *Surg, Gynec & Obstet*, 47, 179, 1928.
- <sup>5</sup> Horrall, O. H., and Carlson, A. J. The Toxic Factor in Bile. *Am J Physiol*, 85, 591, 1928.
- <sup>6</sup> Horrall, O. H. The Toxicity of Bile. *Univ of Chicago Science Series*, 6, 287, 1927-1928.
- <sup>7</sup> Andrews, E., Rewbridge, A. G., and Hrdina, L. Causation of *Bacillus Welchii* Infections in Dogs by Injection of Sterile Liver Extracts or Bile Salts. *Surg, Gynec & Obstet*, 53, 176, 1931.
- <sup>8</sup> Harkins, Henry N. Shift of Body Fluids in Severe Burns. *Proc Soc Exper Biol & Med*, 31, 994, 1934. Experimental Burns. I. The Rate of Fluid Shift and Its Relation to the Onset of Shock in Severe Burns. *Arch Surg*, 31, 71, 1935.
- <sup>9</sup> Harkins, H. N. The Bleeding Volume in Severe Burns. *ANNALS OF SURGERY*, 102, 444, 1935.
- <sup>10</sup> Parsons, Eloise, and Phemister, D. B. Hemorrhage and Shock in Traumatized Limbs. *Surg, Gynec & Obstet*, 51, 196, 1930.
- <sup>11</sup> Blalock, Alfred. Experimental Shock. VIII. The Importance of the Local Loss of Fluid in the Production of the Low Blood Pressure after Burns. *Arch Surg*, 22, 610, 1931.
- <sup>12</sup> Blalock, Alfred. Experimental Shock. The Cause of the Low Blood Pressure Produced by Muscle Injury. *Arch Surg*, 20, 959, 1930.

- <sup>13</sup> Underhill, Frank P , Kapsinow, Robert, and Fisk, Merl E    Studies on the Mechanism of Water Exchange in the Animal Organism    I    The Nature and Effects of Superficial Burns    *Am J Physiol* , 95, 302, 1930
- <sup>14</sup> Domenech-Alsina F , Benaiges, B , Arque, P    Etude du choc provoqué par l'irrigation péritonéale hypertonique    *Compt rend Soc de biol* , 114, 104, 1933
- <sup>15</sup> Scott, H G , and Wangensteen, O H    Blood Losses in Experimental Intestinal Strangulations and Their Relationship to Degree of Shock and Death    *Proc Soc Exper Biol & Med* , 29, 748, 1932
- <sup>16</sup> Elman, Robert, and Cole, Warren H    Hemorrhage and Shock as Causes of Death Following Acute Portal Obstruction    *Arch Surg* 28, 1166, 1934
- <sup>17</sup> Roome, N W , Keith, W S , and Phemister, D B    Experimental Shock    The Effect of Bleeding after Reduction of the Blood Pressure by Various Methods    *Surg, Gynec & Obstet* , 56, 161, 1933
- <sup>18</sup> Harkins H N    Shock Due to Freezing    I    Shift of Body Fluids and Associated Blood Concentration Changes    *Proc Soc Exper Biol & Med* , 32, 432, 1934, Harkins, H N , and Hudson, J E    Shock Due to Freezing    II    Composition of Edema Fluid, *Ibid* , 434, Harkins, H N , and Harmon, P H    Experimental Freezing    Bleeding Volume, General and Local Temperature Changes, *Ibid* , 1142, 1935

# SPINAL EXTRADURAL CYSTS

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EXTRADURAL cysts in the spinal canal which are neither parasitic nor dermoid in origin are rare. Elsberg, Dyke and Brewster,<sup>1</sup> in 1933, reported four cases of extradural cysts which they found in their records among some 250 cases of tumors within the spinal canal. They believed their cases to be the first of this kind to be published. Lehman,<sup>2</sup> in 1935, however, found three previously reported cases, and added two very interesting cases of his own.

**Case Report**—E. S., No. 125153, a white male, age 43, entered the University of Chicago Clinics April 2, 1935, complaining of increasing weakness, weariness and heaviness of both legs and lower part of his back for the past two years, marked chronic constipation for one year, and difficulty in starting the urinary stream for the past few weeks. He had been quite well until 1932 when the right foot and ankle became stiff and soon afterward he noticed the same thing on the left side. He found that after walking a short distance his feet and ankles would become weak and would not support him. This increased until he could walk only a block at a time. He also observed that the weakness was traveling up the legs involving the thigh muscles. In October, 1934, he began having pains, for the first time, in his thighs and hips. The strength of the legs had so markedly diminished that the patient could walk only a few steps. He had noticed muscular twitchings in his thighs and was conscious that the sensation in his legs was not the same as in his arms. The symptoms were much more severe in the right leg. The patient's past history was essentially negative. He had had no serious illnesses, operations or accidents. Other than the above complaints he was in good health.

**Examination**—The general physical examination was negative except for some badly decayed teeth. The cranial nerves and upper extremities were essentially normal. There was loss of cutaneous sensation over the area of the twelfth thoracic dermatome with reduction to pin prick, light touch and temperature over the area of L<sub>1</sub>. In both lower extremities below this level there was a less marked reduction of cutaneous sensation to all stimuli. Response to stimuli was more readily elicited on the left than the right lower extremity. There was complete loss of the sense of position and vibration from the iliac crests down. The sensation of deep pain was grossly reduced in both Achilles tendons. There was definite atrophy in the quadriceps muscles with muscular fibrillation in both anterior and posterior groups of thigh muscles. The knee and ankle jerks were active, especially on the right. There was a sustained ankle clonus with a marked extensor plantar reflex on the right, but none on the left. The Romberg sign was positive and coordination was poor. A tentative diagnosis of a spinal cord tumor was made with the upper level at D<sub>XII</sub>, and spinal puncture and roentgenologic examination of the spine were advised.

The spinal fluid showed an initial pressure of 120. The fluid level in the manometer rose and fell rapidly upon making right and left jugular and abdominal pressure, respectively. It was colorless and contained no cells, showed no increase in protein, and the Wassermann test was negative. The findings of a normal cerebrospinal fluid and absence of obstruction of the spinal canal were rather surprising in view of the clinical

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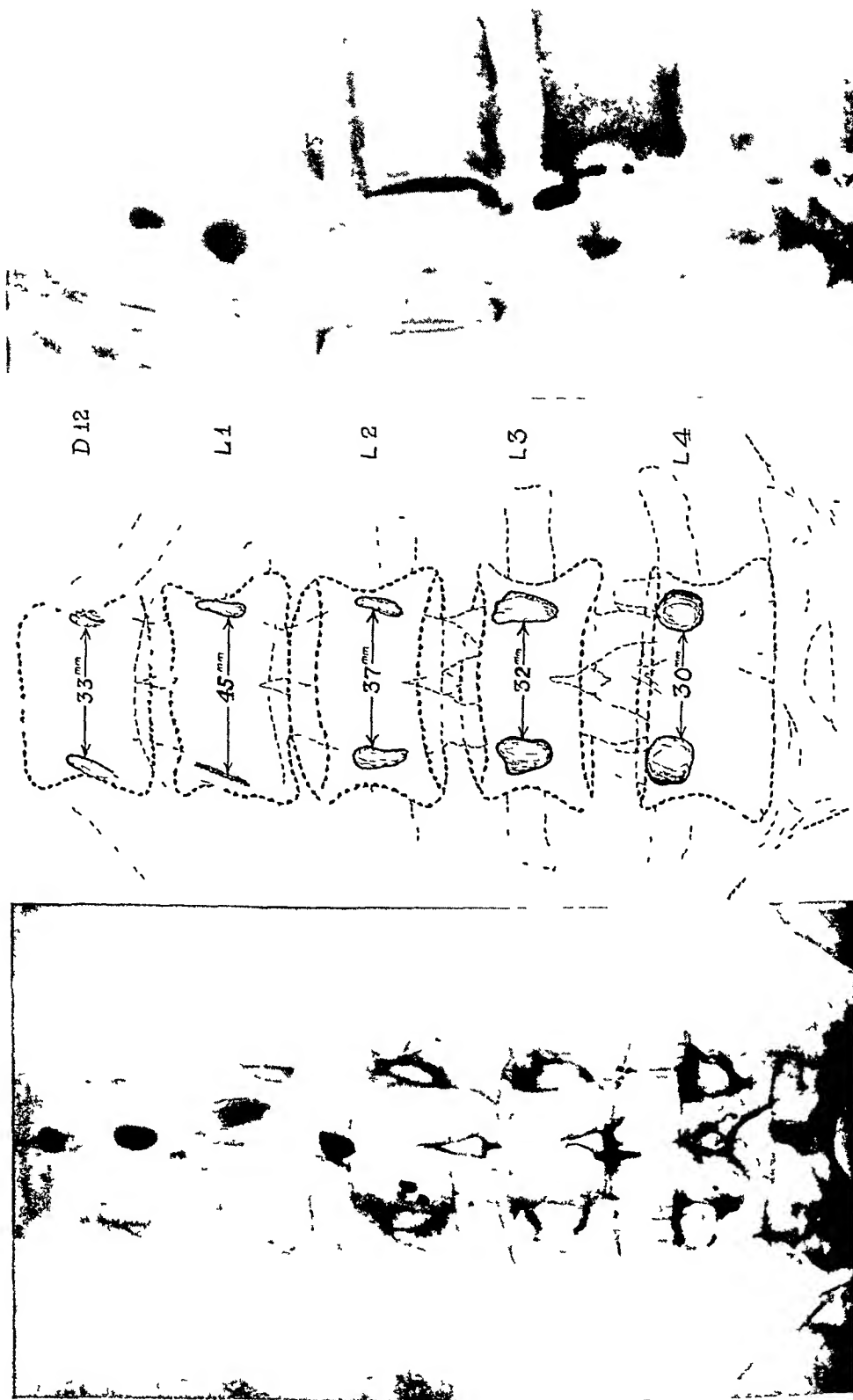


FIG. 1—Roentgenogram showing enlargement of the spinal canal with atrophy of the pedicles of the twelfth thoracic and first second and third lumbar vertebrae. Lipiodol seen above and below the lesion demonstrates the absence of a block in the cerebrospinal fluid.

FIG. 2—Roentgenogram of the lumbar vertebrae, lateral view, showing marked erosion of the dorsal surfaces of the vertebral bodies.



picture, so 1 cc of lipiodol was then injected into the spinal canal. Subsequent developments showed that the use of lipiodol was unnecessary.

*Roentgenologic Examination*—Upon examining the spine fluoroscopically the presence of an expanding intraspinal lesion was obvious, as the spinal canal was markedly widened at D<sub>XII</sub>, L<sub>I</sub>, and L<sub>II</sub>, both in the lateral and anteroposterior diameters, and the pedicles were definitely atrophied. By tilting the patient under the fluoroscope the lipiodol was seen to meet an incomplete obstruction at L<sub>I</sub>, where the column deviated to the left. The eccentric distribution of the lipiodol, above and below the lesion, proved the obstruction to be incomplete and thus accounted for the finding of a normal cerebrospinal fluid. The roentgenograms made at this time (Figs 1 and 2) show the unusual degree of widening of the spinal canal. Upon measuring the interpeduncular spaces of the last thoracic and first three lumbar vertebrae, the vertebral canal was found to be from 2 to 15 Mm wider than normal. The inner border of the pedicles of L<sub>I</sub> and L<sub>II</sub> were either flat or concave instead of the normal convexity shown at L<sub>V</sub>. In the lateral view a marked erosion of the dorsal surfaces of the vertebral bodies was evident by their marked concavity.

*Operation*—A laminectomy was performed April 11, 1935, by Dr Percival Bailey,



FIG 3—Photograph of the large extradural cyst removed at operation from the lumbar spinal canal.

and the arches of the eleventh thoracic to the second lumbar vertebrae were removed. These were very thin and there was no epidural fat. A thin bluish membrane appeared immediately beneath the laminae. It was perforated and a clear fluid escaped. The extent of the cyst was then investigated and the sac was found to be enormous. It was necessary to extend the laminectomy from the tenth thoracic vertebra above to the fifth lumbar below before the complete dissection could be accomplished. Not until these two levels were reached was normal epidural fat encountered. The widest portion of the sac was at the level of the first lumbar vertebra. The cystic sac was easily dissected from the laminae and also from the dura mater. It was attached to the latter only at the first lumbar level by fibrous strands and blood vessels. There was no communication between the cystic cavity and the subarachnoid space. The dura mater was not opened. Doctor Bailey made the following statement in his operative report: "It was very interesting to look into this huge cavity to see how the bodies of the vertebrae had been eroded so that the intervertebral disks stood up like ridges between them."

*Postoperative Course*—With exception of retention of urine for the first three days after the operation, the patient's recovery was speedy and uneventful. On the fourth day he was able to identify temperature and pin prick readily. He was discharged April 28, 1935, with mild spasticity of both lower extremities and weakness of extension.

of the legs, especially on the right. Six months after the operation he was quite well except for a slight limp and some weakness of the right leg. The sensation to vibration and position had returned in both the lower extremities.

*Pathologic Examination—Gross* The tissue removed at operation revealed a large cyst (Fig 3) measuring  $14 \times 5 \times 4$  cm, in its greatest dimensions. The largest diameter was about 3 cm from the upper end and from here it tapered off to a pointed lower end. The outside of the wall was smooth, grayish white, containing very few blood vessels. At either end were small amounts of fat. Four centimeters from the upper end, on the anterior surface, was a band of fibrous connective tissue containing a few medium sized blood vessels. This band was approximately 15 Mm long. Upon opening the sac, the wall was found to be from 1 to 3 Mm thick. The inner surface of the wall was smooth and glistening throughout. Across the junction of the middle and lower third of the cavity was a partial septum which appeared as though the sac may have had, at one time, two separate cavities.

*Microscopic Examination*—The wall of the cyst seemed to be composed of two

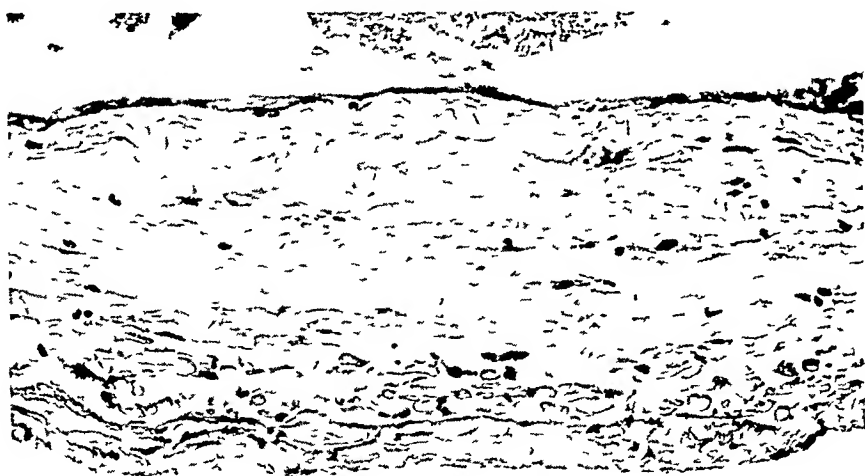


FIG 4—Photomicrograph of a cross section of the cyst wall showing endothelial lining. Hematoxylin and eosin stain ( $\times 300$ )

layers of fibrous tissue, a thin longitudinal outer layer and a much thicker circular inner layer. The tissue was a rather acellular collagenous connective tissue. There were very few blood vessels. In places a definite single layer of cells resembling endothelium could be seen lining the inner wall of the cyst (Fig 4).

**DISCUSSION**—There were many interesting findings not recorded in other similar cases. The patient was a male, age 43, who had been perfectly well until two years before admission when he began to experience gradually increasing weakness and spasticity of both legs with muscular twitches. It was not until nearly two years after the onset that he began having pain in the lower extremities, with change in the sensation of the skin and urinary disturbances. At no time, however, was pain the major complaint.

The changes in the motor system consisted of marked loss of power, muscular fibrillations and definite atrophy of the quadriceps muscles of both lower extremities, with symmetrically increased deep tendon reflexes. The Babinski sign was positive, and sustained ankle clonus could be obtained on the right side only. The motor involvement was in all probability due to indirect compression of the anterior surface of the spinal cord and roots against the

hard bodies of the vertebrae by the fluid containing sac. This compression must have interfered with the pyramidal tracts more than the anterior horn cells, since spasticity was much more prominent than atrophy.

The sensory system was less involved than the motor system. Sensibility to pain, touch and temperature, with the exception of the twelfth thoracic dermatome, was only slightly impaired. However, sense of vibration and of position was completely lost in both lower extremities from the hips down. The widest portion of the cyst was located at about the level of  $L_1$ . The extreme lateral pressure on the twelfth thoracic posterior roots of the spinal cord had cut off all sensory pathways at this level, whereas the pressure below  $D_{XII}$  being not so great, the sensory changes below were only slight. The bulk of the cyst pressing directly on the posterior columns had probably impaired the vibratory and position sense early in the course of the illness.

It is difficult to explain why pain in these cases is so conspicuously absent, even when the lesion attains the enormous size it did in this case. Pain, when it is present with spinal tumors, is usually due to irritation of the posterior nerve roots. Absence of pain, then, in this case is all the more surprising since the twelfth thoracic roots had apparently been involved to such an extent as to produce complete anesthesia of the corresponding dermatome.

The extensive atrophy of the dorsal surfaces of the vertebral bodies would indicate that the cyst had gradually and progressively grown larger, probably from continued secretion of fluid within, exerting persistent pressure on the bony surfaces. It is therefore difficult to understand the absence of obstruction to the spinal canal in the presence of a tumor mass obviously large enough to completely fill the canal, as one would suppose from the eroded vertebral pedicles. However, that the cyst did not completely fill the spinal canal at all times is evident from the results of the lumbar puncture.

In Lewis' surgery extradural cysts are said to be either parasitic or dermoid in origin (with one exception which will be mentioned later). The cyst here reported belongs to another rarer group. They are thin walled sacs, either monolocular or multilocular, single or multiple, and filled with a clear, colorless fluid not unlike cerebrospinal fluid. The wall is composed of rather acellular fibers of connective tissue and has a lining of a single layer of flat cells resembling endothelium or the lining cells of the arachnoidal membrane. The cysts are attached loosely to the dura mater by thin fibrous bands which may be collected in a small pedicle or extend the full length of the cyst. The blood supply to the cyst usually comes from the dura mater through these bands.

The origin of these cysts is a matter of speculation. Elsberg, Dyke and Brewer suggest that they may have originated as a "congenital diverticulum of the dura mater" or "a herniation of the arachnoid through a congenital defect in the dura mater." Later the channel of communication becomes obliterated and reduced to a fibrous band, but the cyst continues to enlarge from a secretion of its own lining cells. The latter hypothesis is probably correct, for in one of the cases reported by Lehman the cyst did communicate with the subarachnoid space through a small patent pedicle and, when the cyst

was opened, cerebrospinal fluid escaped. In all other cases reported, however, the small fibrous band of attachment to the dura mater was all that remained of the original pedicle.

After studying the four cases referred to in his pathologic material, Elsberg searched the literature for similar cases and found none. However, Lehman was able to find three other cases of extradural nonparasitic cyst possibly similar to those under consideration. They were reported by Schlesinger, in 1898, by Krause, in 1908, and by Mixter,<sup>3</sup> in 1932. The details concerning these cases are given by Lehman.<sup>2</sup> The two early cases are not very clear but that of Mixter, which appears in Lewis' surgery, seems to be identical with the present case. The cyst, however, was multilocular and extended from the third to the seventh dorsal vertebra. The symptoms began at the age of 12 (Table I).

TABLE I  
RECORDED CASES OF SPINAL EXTRADURAL CYST

CASE NO	DATE	REPORTED BY	AGE ON ADM	DURATION OF SYMPTOMS	SEX AND COLOR	OPERATOR	LOCATION	NUMBER OF CYSTS FOUND	X-RAY EVIDENCE OF DILATATION OF SP. CANAL	VARIABILITY OF SYMPTOMS	RESULTS
1	1898	Schlesinger	?		?	None	Midthoracic	2	?	?	Postmortem finding
2	1908	Krause	46	2 years	M W	Park	3rd to 6th dorsal	1	?	None	Incomplete cure
3	1932	Mixter	26	14 years	M W	Mixter	3rd to 7th dorsal	1	?	Marked	No Improvement
4	1934	Elsberg, Dyke Brewer case 1	12	3 years	M W	Stokey	6th to 11th dorsal	1	Present	Marked	Incomplete cure
5	"	" case 2	15	3 months	M W	Elsberg	6th to 9th dorsal	1	"	None	Cured
6	"	" case 3	15	9 months	M W	"	5th to 9th dorsal	1	"	"	Incomplete cure
7	"	" case 4	16	2 years	F W	Taylor	Midthoracic	1	?	"	Cured
8	1935	Lehman case 1	12	3 months	M C	Lehman	6th to 9th dorsal	2	Present	Marked	Cured, Kyphosis
9	"	" case 2	17	9 months	M C	Bunch	6th to 10th dorsal	1	?	None	Cured, Kyphosis
10	1936	Cloward	43	2 years	M W	Bailey	11th dorsal to 4th lumbar	1	Present	"	Incomplete cure

The four cases of Elsberg, Dyke and Brewer were all in adolescents, all had symptoms of compression of the spinal cord, and all four cysts were located in the midthoracic region. The character of the cysts was entirely similar to the one herein described. They were attached to the outer surface of the dura mater only at a point near the exit of the posterior roots. Bony changes in the spinal canal were observed as in our case.

The two cases reported by Lehman were both in adolescents, the cysts also were in the midthoracic region and were typical pathologically. In each case the symptoms were marked by a predominance of motor involvement, with an incomplete sensory loss below the level of the lesion. One very significant observation made in Lehman's first case was the fluctuation of symptoms, particularly exacerbation and remission of the subjective complaints. It was

in this case that the patent channel of communication between the cyst and the subarachnoid space was found. Lehman supposed that these cysts fill out and empty intermittently, thus changing the degree of pressure on the spinal cord from time to time. When this channel closes permanently and the lining of the cyst continues to secrete, the symptoms then progress steadily with the expanding of the sac. This intermittency of symptoms early in the clinical course is offered by Lehman as being of diagnostic significance.

Elsberg has formulated what he calls a "characteristic syndrome" of compression of the spinal cord by an extradural cyst which includes the following: "The individual is an adolescent, the tumors are usually found in the mid-thoracic region, *i e*, between the 4th and 10th thoracic vertebrae, the manometric tests demonstrate a subarachnoid block with characteristic spinal fluid changes of cord compression, and pain is absent or not a prominent symptom."

In our case there may be some connection between the location of the cyst and the age of the patient. All certain cases heretofore reported were found in the midthoracic region and all in adolescents. There is a possibility that when the cyst is located in the lumbar region, where the spinal canal is larger in all its dimensions, it may develop for a longer period before producing symptoms.

From the findings in our case we may conclude that spinal extradural cysts may be found also in adults, that they may be located also in the lumbar region, and that even though they reach an enormous size there may be a normal manometric test and no changes in the spinal fluid. The enlargement of the spinal canal with atrophy of the pedicles as seen in the roentgenograms, and the relative absence of pain seem to be the only findings that are common to all cases. These are by no means pathognomonic, however, as they may be observed also in other tumors within the spinal canal, both extramedullary and intramedullary.

#### REFERENCES

- <sup>1</sup> Elsberg, C. A., Dyke, C. G., and Brewer, E. D. The Symptoms and Diagnosis of Extradural Cysts. *Bull. Neurol. Inst. New York*, 3, 359-417, March, 1934.
- <sup>2</sup> Lehman, E. P. Spinal Extradural Cysts. *Amer. J. Surg.*, 28, 307-322, 1935.
- <sup>3</sup> Mixer, W. J. Practice of Surgery, Pryor, Ed. by Dean Lewis. 12, Chap. 111, 52-68, 1932.

## SACROCCYGEAL TERATOMA\*

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THE sacrococcygeal region is a common site for the occurrence of a variety of fistulae, cysts and tumors. Because of the multiplicity of possible factors in their derivation and the variability of their structure, no rigid classification of these lesions has as yet been effected. Many of them are relatively common (pilonidal cysts and sinuses, sacral meningocele,† *etc* ) and seldom offer diagnostic difficulties. Much less frequent are the teratomatous tumors which in rare instances have been described as an integral part of an anomaly of the neural canal. These in general are the tumors presenting on the dorsal aspect of the sacrum. Another group, histologically similar, have no important connections with the spinal cord or its membranes but are attached to the coccyx or distal portion of the sacrum. They lie chiefly in front of the sacrum and coccyx but, when large, protrude posteriorly and resemble superficially the sacral meningocele. Three cases of this type herein reported were in fact, referred to one of us (J B ) with the diagnosis of meningocele.

We are presenting four cases of sacrococcygeal teratoma and, for comparison, one example of sacral meningocele to illustrate the respective diagnostic features. The relative ease with which the teratomata were extirpated, and the excellent results obtained, contrast strikingly with the difficulties and discouraging prognosis usually attendant upon the surgical treatment of the sacral meningocele.

### CASE REPORTS

Case 1—H C, a two months old male, was admitted to the Pediatric Service of Dr Carl Laws at the Long Island College Hospital February 10, 1925. He was the fourth child of normal parents. At birth two small lumps were present over the lower end of the spine but subsequently they gradually became larger and fused into a single tense tumor which "felt as if it had fluid inside it." No weakness of the lower extremities had been observed nor were there any urinary or rectal difficulties.

*Physical Examination*—There were no abnormalities other than a large tumor attached to the buttocks (Fig 1). The mass was covered with true skin, its surface was lobulated and its base sessile, displacing the anal orifice to the left. The lobulations were fairly soft, seemed cystic but could not be reduced. Rectal examination disclosed a smooth elastic tumor filling the pelvic outlet to such an extent that the examining finger impinged upon the under surface of the symphysis pubis. The external anal

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†The term meningocele is employed throughout this paper to indicate not only this specific anomaly but also the related meningoceles, the syringomyeloceles and the syringomeningomyeloceles.

sphincter appeared normal. No cutaneous sensory disturbances could be demonstrated over the buttocks, and the lower extremities showed no abnormalities of function. When the child cried the mass did not increase in size or become more tense. Roentgenologic examination showed the coccyx to be displaced posteriorly.

*Operation*—By Dr. Emil Goetsch. Under ether anesthesia, the base of the tumor was outlined by an elliptical cutaneous incision leaving the skin covering the tumor in situ. By sharp and blunt dissection the mass was freed from the surrounding structures without difficulty. The tumor was found to be attached to the coccyx which was therefore amputated at the sacrococcygeal junction. There was no demonstrable attachment elsewhere. The wound was closed without drainage. There was an immediate postoperative rise of temperature to  $104.2^{\circ}\text{F}$  which gradually subsided during the following three days. A small area of the wound was superficially infected but slowly granulated and at the end of a month was completely healed. The child was discharged from the hospital April 7, 1925, in excellent condition.

*Pathologic Examination*—*Gross*. The specimen consisted of a coarsely lobulated mass covered in part by normal skin. It measured approximately  $12 \times 10 \times 6\text{ cm}$ . On section it was found to contain several irregular shaped cavities filled with straw colored fluid. These cavities had smooth lining surfaces and their walls were trabeculated. The solid portions were divided into nodules of varying consistency, separated by connective tissue septa. No parenchymatous tissue could be identified as such. *Microscopically* the solid portions of the tumor consisted mainly of lobulated masses of brain tissue with varying degrees of gliosis. An occasional island of bone formation was noted. Scattered in an irregular manner were clusters of cells suggesting compound racemose glands. The cystic spaces were lined with epithelium, resembling bronchial and gastro-intestinal mucosa. Interspersed throughout was much adipose and connective tissue.

Five years later, in April, 1929, it was reported that the child was living and well with no evidence of recurrence of the tumor.

*Case 2*—R. T., a three months old female, was admitted to the Surgical Service of Dr. Emil Goetsch at the Long Island College Hospital July 30, 1925. This was the second child of normal parents. It had been delivered by a midwife who noticed a small tumor over the lower end of the spine. This mass was soft and covered with normal skin. There were no abnormalities of the lower extremities. There had been slight increase in the size of the mass since birth.

*Physical Examination*—The child was well developed and weighed 12 pounds. Nothing of importance was noted except in the coccygeal region where a round mass could be seen. The overlying skin was freely movable and showed no discoloration. Bimanual palpation with a finger in the rectum disclosed an oval shaped resilient mass about the size of a small lemon apparently attached to the coccyx. There was no increased tension of this structure during forceful crying nor could its contents be reduced. The external anal



FIG. 1.—(Case 1) An example of a sacrococcygeal teratoma with a moderately large externally visible portion.

sphincter seemed normal. No cutaneous sensory changes or motor weakness of the lower extremities could be demonstrated.

*Operation*—Under ether anesthesia, the mass was exposed through a transverse cutaneous incision. It was ovoid in shape, had a smooth surface, and at its cephalad end was fused with the first coccygeal segment. The remainder of the coccyx could not be identified as such. The tumor with the involved coccyx was amputated at the sacro-coccygeal articulation. The wound was closed without drainage. Shortly after operation the temperature rose to 104° F but returned to normal within 24 hours. The remainder of the patient's stay in the hospital was uneventful and she was discharged August 16, 1925.

*Pathologic Examination—Gross* The specimen consisted of an oval shaped mass measuring 6 x 4 x 3 cm. On section it was found to be composed of a solitary cyst with a smooth glistening lining and an irregular intramural nodule 2 x 3 x 2 cm. The cut surface of this nodule was grayish white and appeared to be composed of cellular areas and connective tissue septa.

*Microscopic*—Throughout, numerous small islands of brain tissue were distributed. In close proximity to one of the larger areas of brain structure there was a pouch lined by squamous epithelium. In other areas convoluted glands lined with ciliated columnar epithelium were seen. The lining of a number of small cystic spaces resembled gastrointestinal mucosa.

Recent examination showed a normal girl now ten years old, without any demonstrable abnormalities.

**Case 3**—S. B., a ten day old female, was born at full term in the Methodist Episcopal Hospital June 15, 1932. Following the delivery there was seen a large lobulated tumor protruding from the region of the buttocks and displacing the anal orifice to the left. During the next ten days the mass grew appreciably larger. The infant urinated and defecated in a normal manner. No disturbance of the function of the lower extremities was noted.

*Physical Examination*—The child was a well developed and well nourished female infant with a prominent tumor mass protruding from the region of the right buttocks, approximately one-third the size of the infant's trunk, and completely covered with normal skin. On transillumination shadows could be seen which suggested septa between several cystic lobules. Rectal examination disclosed that the mass extended into the pelvis and almost completely filled its outlet. The anal sphincters functioned normally. No sensory or motor changes could be demonstrated.

*Operation*—June 28, 1932. Under local anesthesia an elliptical incision was made about the base of the mass. By dissection, it was easily freed from the surrounding structures. A solid portion was fused with the coccyx necessitating division of the sacro-coccygeal articulation. The wound was closed without drainage. There was a sharp postoperative rise of temperature to 103° F, but otherwise the postoperative course was uneventful. At the close of the operation a transfusion of blood was given.

*Pathologic Examination—Gross* The specimen measured approximately 22 x 12 x 10 cm. Its surface was irregular and the larger lobules had thin bluish semitranslucent walls. It appeared that about one-third of the mass was made up of solid tissue. Unfortunately the specimen was lost without further examination being made.

The child returned recently for examination and was found to be normal except for considerable atrophy of the buttocks, more marked on the right side (Fig. 2).

**Case 4**—J. S., a six months old male, was admitted to the Kings County Hospital August 28, 1935. At birth there was observed a protrusion about the size of a lemon situated just dorsal to and slightly to the right of the anus. It had grown much larger in the interval and displaced the anus to the left side. For three months there had been a moderate degree of constipation relieved by enemata. No urinary disturbance or weakness of the lower extremities had been noticed.

*Physical Examination*—The findings were unimportant except for the presence of



## SACROCOCCYGEAL TERATOMA

a rounded mass about the size of the infant's head attached by a broad base to the region of the buttocks. This could not be reduced nor was there any increase in its size when the child cried. The external anal sphincter was functioning but there was leakage of fecal material due to its being stretched. The urinary apparatus seemed normal. No motor or sensory disturbance was demonstrable in the lower extremities.

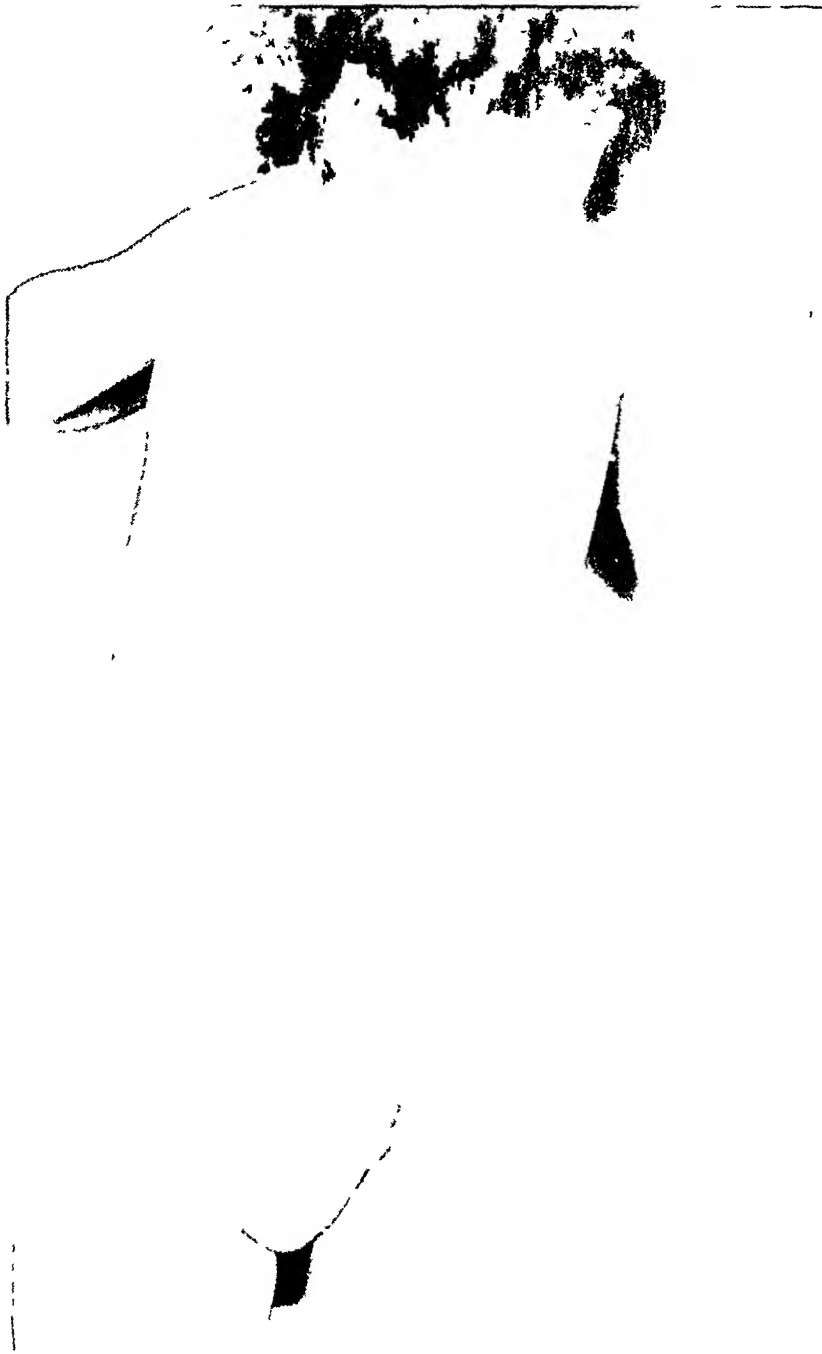


FIG 2—(Case 3) Four years after operation showing atrophy of the buttocks

Roentgenologic examination of the pelvis showed opaque structures in the mass resembling rudimentary phalanges.

*Operation*—August 3, 1935. Under ether anesthesia an elliptical incision was made about the dome of the tumor. The right gluteus maximus muscle was atrophic. The mass was easily dissected from the surrounding structures and was found to be firmly attached to the coccyx. The sacrococcygeal articulation was therefore divided. The wound was closed with drainage. At the end of the operation a transfusion of blood was given. There was a sharp postoperative rise in temperature to  $105^{\circ}\text{F}$  which returned to normal on the third day, the subsequent course in the hospital was uneventful.

*Pathologic Examination—Gross* The excised mass (Fig 3) was irregularly ovoid and was partially covered by normal skin. It measured 13 x 10 x 9 cm. Immediately beneath the skin was a large dermoid cyst filled with cheesy material which comprised the greater part of the entire tumor. A nodule of solid tissue, protruding into the cyst, was covered by epidermis with a macerated surface. From this nodule a number of long hairs projected into the cyst cavity. The remainder of the tumor was continuous with the dermoid anlage and lay just outside of the superior pole of the large cyst. This portion was composed of solid gray white tissue in which numerous small cystic cavities were distributed. The latter contained, for the most part, translucent gelatinous material. Several nodules of bone were also encountered on sectioning the tissue. *Microscopic* examination of various portions of the tumor (Fig 4, A, B, C, D) showed



FIG 3—(Case 4) Shows the teratomatous mass removed containing a large dermoid cyst

structures clearly identifiable as gastric and intestinal mucosa, pancreatic tissue, glottic brain tissue, choroid plexus, and salivary glands. There were also islands of bone with active bone marrow, cartilage, smooth muscle, myxomatous and adipose tissue. The large cyst contained desquamated epithelium, hair and the secretions of dermal glands situated in the solid portion of its wall. The smaller cysts were derived from mucus secreting epithelial membranes of various types.

Examination nine months after operation showed considerable atrophy of the buttocks, more marked on the right side. Otherwise the child was well developed and appeared in perfect health.

Since this paper was submitted for publication J. S. (Case 4) was readmitted to the hospital with mild abdominal distention and inability to defecate. Rectal examination disclosed a hard, fixed mass encircling the rectum just within the internal anal sphincter. The extent of the mass could not be determined. There was a rapid growth of this obviously malignant tumor during the next two months and death occurred November 20, 1936. Autopsy disclosed extensive invasion of the pelvis, buttocks and retroperitoneal lymph nodes. Histologically the tumor was found to be of undifferentiated cell type and was interpreted as an embryonal carcinoma.

# SACROCOCCYGEAL TERATOMA

Case 5—S S, a three year old male, was admitted to the Kings County Hospital January 10, 1934. At birth there was noted a small protruding mass at the lower end of the spine, which was soft and had a bluish color. The mass had remained about the same size since birth. There had been urinary and fecal incontinence. The child



FIG. 4—Photomicrographs of portions of the specimen shown in Fig. 3. (A) Skin with dermal glands and hair follicles from the dermoid anlage. (B) Gastric mucosa. (C) Pancreatic tissue. (D) Mucus secreting glands probably belonging to the salivary apparatus.

had never been able to walk without assistance. He was brought to the hospital because of the urinary incontinence.

Physical Examination disclosed an undernourished, pot bellied, markedly dehydrated child with a rounded tumor in the region of the sacrum (Fig. 5). The head, upper

extremities and trunk presented no unusual findings. The sacral mass was covered over its distal portion with scaly, embryonal skin. The mass was cystic, could be partially reduced and became quite tense when the child cried. A bony defect in the sacrum was easily palpable. The anal orifice was open and no contraction of the external sphincter was noted. The thighs and legs could be voluntarily flexed and extended but there was no voluntary control of the feet. Complete cutaneous anesthesia and analgesia could be demonstrated from the first sacral dermatome downward.

*Operation*—Under ether anesthesia, the mass was explored and there was found an embryonal spinal cord attached to the dome of the meningocele cavity. Atrophic



FIG 5—(Case 5) A sacral meningocele, included for comparison

spinal nerves passed from this cord through the sacral foramina. The spinal cord was detached and the sacral defect repaired. On the third postoperative day there developed evidences of meningitis from which the child died two days later.

*Pathologic Examination*—*Gross* The specimen consisted of a portion of the wall of a meningocele, covered on its outer surface by wrinkled embryonal skin and on its inner surface by a glistening membrane. Beneath the lining was seen an area of tissue resembling a prolongation of the spinal cord. *Microscopically* there was seen a mass of nerve tissue containing scattered groups of ganglion cells, irregular fiber tracts and patches of glial overgrowth, the latter projecting into the surrounding connective tissue. One surface was covered by atrophic skin.

DISCUSSION —The subject of malformations and new growths in the sacrococcygeal regions has occupied a prominent position in medical literature of the past 50 years. To attempt a review of the large volume of accumulated data and discussions pertaining to the subject seems unwarranted. The reader is therefore referred to articles by von Beigmann,<sup>1</sup> von Recklinghausen,<sup>2</sup> Kummel,<sup>3</sup> Malloiy,<sup>4</sup> Boist,<sup>5</sup> and Schwalbe.<sup>6</sup> A variety of local embryonal structures have been drawn upon to explain the origin of the various fissures, fistulae, cysts and tumors so common in this region. Among these are the fovea coccygea and the coccygeal vestiges of the neural canal, the neurenteric canal, the post-anal gut and the proctodeal membrane. According to Ewing,<sup>7</sup> although some of the tumors may, with considerable certainty, be referred to single embryonal structures, the majority of them are more complex and probably involve more than one of these embryonal remnants or some additional anomalies of development. The concept that teratomata may arise from parthenogenetically developing sex cells, a modification of the old "bigerminal theory," has been given much support by the researches of Bosaeus<sup>8</sup> on the origin of ovarian embryomata. He removed from frogs' ovaries unfertilized ova, pricked them with a needle, as Jacques Loeb had done, to stimulate parthenogenetic development, and then reimplanted them into the lymph sac, pleural cavity or ovary of the particular frog from which they had been taken. From these ova complicated teratomata developed that had "essentially the same structure as the spontaneous adult teratomata or cystic embryomata." MacCallum<sup>9</sup> favors this explanation for the development of teratomata of the gonads where they are often accompanied by chorionic membranes, but holds that the teratomatous tumors in the sacrococcygeal region and brain which approach the complexity of twin inclusions, and even the simplest cysts composed of only one or two types of tissue, are best explained as originating from isolated somatic blastomeres with varying potentialities. A teratoma resulting from parthenogenetic development of a sex cell would be of the nature of an offspring while one derived from an isolated blastomere would be of the same generation as the host, a twin.

It is generally recognized that teratomata such as we have described are benign growths but that one of their component tissues may undergo malignant degeneration. In reporting a case of "Sacrococcygeal Carcinomatous Teratoma," Stewart, Altei and Craig<sup>10</sup> comment that malignancy in such lesions in childhood is either not as common as it is generally thought to be or the cases have not been reported, for they were able to find only four other instances in the literature. These authors quote a statement by Gant<sup>11</sup> to the effect that teratomata in this region show a tendency to undergo cancerous degeneration unless excised early. Renner and Goodsitt<sup>12</sup> have recently reported the case of an infant from whom a "tail-like mass," a teratoma, was removed shortly after birth. The tumor did not appear to extend into the pelvis and no pelvic mass was palpable at that time. Ten months later the child developed constipation and inability to void, and was found to have a

large malignant teratoma located between the rectum and the sacrum and infiltrating the rectal wall. The intrapelvic tumor, which these authors considered as a second or independent tumor, could probably have been successfully extirpated had it been recognizable at the time of removal of the externally visible mass.

Early complete excision of these tumors is indicated as a prophylaxis against malignant change if for no other reason. Also the external portions are not only unsightly but easily vulnerable, while the intrapelvic portions, which are frequently the larger, may cause various pressure effects.

The meningoceles, meningomyeloceles and meningesyringomyeloceles are all the result of defective development of the neural canal. The protruding mass may show a superficial resemblance to the sacrococcygeal teratomata but the two classes of lesions can usually be differentiated by the following features.

**DIFFERENTIAL DIAGNOSIS** —(1) The skin covering of the teratomata is true skin whereas the meningomyeloceles are usually covered with thin "embryonal skin" which is easily eroded and ulcerated.

(2) The teratomata vary widely in size. They may protrude but slightly from the pelvis, indeed may be entirely intrapelvic, or present as huge external masses the size of the infant's head or larger, with a palpable intrapelvic portion as well. The meningomyeloceles, on the other hand, are seldom so large and, except in the case of the rare "anterior meningoceles," there is no extension into the pelvis.

(3) A rapid increase in the size of the teratomata is usually noted in the early months of life. This, according to Hansmann and Berne,<sup>13</sup> parallels the growth of the infant and should not be taken as evidence of malignancy. The meningomyeloceles show no such rapid increase in size.

(4) Most of the teratomata can be recognized as containing both solid and cystic portions. They are not reducible and show no enlargement or increased tension when the child cries, or when the jugular veins are compressed. The meningomyeloceles are distinctly cystic and show the various evidences of communication with the spinal subarachnoid space.

(5) The teratomata are associated with no motor or sensory disturbances except, in rare instances, where the tumor presses on the lumbosacral plexuses. The cases of the meningomyelocele group are commonly characterized by loss of sphincteric control and sensory and motor disturbances of the buttocks and the lower extremities.

(6) Hydrocephalus is not encountered in cases of sacrococcygeal teratoma whereas it is often present in the examples of meningomyelocele, particularly after surgical removal of the meningocele sac.

**OPERABILITY** —Regarding the operability of sacrococcygeal tumors, we are aware of the fact that not all of the cases offer the favorable outlook of those we are reporting. In each of our four cases the tumor was composed of well differentiated tissues in which no evidence of malignant degeneration was found. In each instance there was no associated spinal cord or spinal

canal anomaly, the tumor was not attached to other important structures and excision was accomplished without great technical difficulty. The fact that all four cases were in infants with tumors externally visible at birth, made early diagnosis and early operation possible. When this is not the case such tumors may go unnoticed until adult life when symptoms of compression of pelvic structures may develop as a result of sudden growth activity. Some of the cases in the group reported by Hundling<sup>14</sup> were undoubtedly of this type. Teratomatous masses have been encountered in association with spina bifida occulta (von Recklinghausen<sup>2</sup>). Keen and Coplin<sup>15</sup> found a fistulous tract passing through a defect in the sacrum and communicating with the rectum in a case of sacrococcygeal teratoma. Such cases present very different surgical problems from those encountered in our series.

#### CONCLUSIONS

We are of the opinion that a large majority of the sacrococcygeal teratomata in infants are benign, that they can be clinically differentiated from the cases of the meningocele group, and that they are not attached to important structures and should therefore be operated upon as early as possible with the expectation of good functional results. The only residual abnormality to be expected is atrophy of the gluteal muscles in instances where the tumor is very large.

#### REFERENCES

- <sup>1</sup> von Bergmann, E. *Berl klin Wchnschr*, 48, 761, 780, 1884
- <sup>2</sup> von Recklinghausen, F. *Virchows Arch f path Anat*, 105, 243, 373, 1886
- <sup>3</sup> Kummel, W. *Virchows Arch f path Anat*, 118, 37, 1889
- <sup>4</sup> Mallory, F B. *Am J M Sc*, 103, 263, 1892
- <sup>5</sup> Borst, Max. *Centralbl f allg Path u path Anat*, 9, 449, 1898
- <sup>6</sup> Schwalbe, E. *Die Morphologie der Missbildungen des Menschen und der Tiere I Teil Allgemeine Missbildungslehre* G Fischer, Jena, 1906
- <sup>7</sup> Ewing, J. *Neoplastic Diseases* W B Saunders Co, Philadelphia, 1928
- <sup>8</sup> Bosaeus, W. *Genese d Ovarialembryome Akad Abhandl*, Uppsala, 1926. Quoted by MacCallum
- <sup>9</sup> MacCallum, W G. *Text-book of Pathology* W B Saunders Co, Philadelphia, 1932
- <sup>10</sup> Stewart, J D, Alter, N M, and Craig, J D. *Surg, Gynec & Obstet*, 50, 85, 1930
- <sup>11</sup> Gant, S G. *Diseases of the Rectum and Colon*, 2, 263. W B Saunders Co, Philadelphia, 1923. Quoted by Stewart, Alter and Craig
- <sup>12</sup> Renner, R R, and Goodsitt, E. *Am J Cancer*, 24, 217, 1935
- <sup>13</sup> Hansmann, G N, and Berne, C J. *Arch Surg*, 25, 1090, 1932
- <sup>14</sup> Hundling, H W. *Surg, Gynec & Obstet*, 38, 518, 1924
- <sup>15</sup> Keen, W M, and Coplin, W M L. *Surg, Gynec & Obstet*, 3, 661, 1906

## CANCER OF THE TONGUE

A REPORT OF ONE HUNDRED AND EIGHTY-SEVEN CASES, WITH AN ANALYSIS OF  
NINETY-EIGHT TREATED PRINCIPALLY BY SURGERY AT THE NEW YORK SKIN  
AND CANCER HOSPITAL BETWEEN 1917 AND 1935

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THE treatment of tongue cancer at the Skin and Cancer Unit of the New York Post-Graduate Hospital is based on the belief that thorough surgical removal of the tongue lesion by the knife or the electrocautery, combined with a block dissection of all the superficial and deep cervical nodes, whether clinically showing evidence of metastases or not, is the most rapid and effective means of eradication and gives the greatest assurance of freedom from recurrence. At the same time, the value of radiotherapy in certain cases is well recognized, but, in general, radium and roentgen ray are reserved for the more radiosensitive types of tumors, for cases upon whom prolonged operative procedures are contraindicated, either on account of the age or condition of the patient or the location and extent of the lesion, and as a palliative measure for hopeless cases.

For the purpose of determining the results these principles of treatment were giving, a study of the records of tongue cancer treated during the last 19 years was undertaken. A review of the literature on cancer of the tongue for the last five years was also made, mainly with a view of comparing our own results with those of other institutions devoted to the treatment of cancer. This study, however, has not proved as helpful as was anticipated, first, because the material upon which statistics are based must necessarily vary in different groups, and secondly, on account of the lack of uniformity in the methods of compiling statistics. The chief difficulty in this respect arises from the failure of everyone to adopt a uniform interval following treatment in reporting so called "cures." Another source of confusion lies in the fact that many writers group their tongue cases with cancers of other parts of the mouth under the heading of intra-oral or mouth cancer, and include with tongue cases cancers of the cheek, gums, tonsils, soft palate, and often cancer of the lip. While it is true that mouth cancers are usually of the squamous cell type, yet in different locations they vary as to the malignancy and their response to radiation, and, what is more important, the rapidity with which they metastasize and the paths along which metastases occur. Thus, to compare the results of one method of treatment employed in a group of tongue cases alone, with some different form of treatment applied to a group in which are



included cancers from other parts of the mouth, can result only in misleading conclusions

One fact that stands out from even a cursory review of the voluminous literature on the subject is that authorities are far from being in accord on the treatment of tongue cancer. Surgery, electrosurgery, and radium are each advocated for the treatment of the tongue lesion by their supporters, while for the treatment of the lymphatics draining the area involved we find such a variety of procedures employed that one is quite bewildered. There is no doubt that in recent years there has been a very definite trend from surgery toward the use of radium in the treatment of the cervical nodes as well as the tongue lesion. For this reason, it was thought a report of the results in an unselected group of tongue cancers which were, for the most part, advanced, and in which the treatment with few exceptions was surgical, would be of interest.

Among the files of malignant tumors of the tongue examined or treated at this hospital during the period from 1917 to 1935, inclusive, there were 202 cases listed under carcinoma and two under sarcoma. Eighty-eight of the patients had a clinical diagnosis only, while in 114 the diagnosis was confirmed by biopsy or a complete tissue examination after operation. All of the latter were of the squamous cell type, except one lympho-epithelioma. Three cases were associated with other cancers. In one there was also a squamous cell carcinoma of the upper lip and a basal cell carcinoma of the back. Another had, in addition to the tongue lesion, a basal cell carcinoma of the nose. In the third case, there was also a carcinoma of the breast (clinical diagnosis only).

The correctness of the clinical diagnosis appears doubtful or was later disproved in six cases. In three of these, the lesion healed after extraction of teeth, two of them being followed for one year and three years, respectively, without recurrence. A fourth case was treated for syphilis and at the end of a year showed no pathology of the tongue. The histologic report on a fifth case, after hemiglossectomy, was a tuberculous ulcer of the tongue. The sixth case had a part of the tongue and floor of the mouth removed and a bilateral cervical node operation, the pathologic examination showing only inflammatory changes. Nine others were either primary carcinomata of the tonsil or floor of the mouth which had spread to the tongue.

Many of the remaining 187 cases were far advanced or inoperable when they applied for treatment. In 31 histories from the entire group, it is definitely stated that the cases were inoperable, but there are at least 32 others which, from the description of the lesion or the condition of the cervical nodes, should be classed as such, giving a total of 63 (33 per cent) that were inoperable when they came to the clinic. If the criteria of inoperability laid down by Quick<sup>1</sup> and others, such as the presence of bilateral palpable nodes, were followed, the percentage of inoperable cases would be considerably higher. Thirty-nine (20 per cent) gave a history of having received some form of previous treatment, such as cauterization, the use of radium, or incomplete operation.

UNTREATED CASES—Fifty of the 187 cases were disposed of as follows. Twenty-two were admitted to the hospital and discharged within a few days without receiving any treatment. Half of these were signed out as inoperable. There were no reasons stated why the remaining cases were not treated, but, from an examination of the histories, it is evident that many of them were in a similar condition. Seventeen were advised to enter the hospital for treatment, but failed to do so or went elsewhere, eight were sent to other hospitals for radiotherapy, two were sent direct to a home for incurables, and one died while in the hospital.

INOPERABLE CASES TREATED BY RADIOTHERAPY—Thirty-four cases were treated solely by roentgen therapy or radium. The majority of these patients were in an advanced or inoperable stage of the disease, and were referred to the radiotherapy department for palliative treatment. As there were no five year survivals among this group, all cases from 1917 to 1935 are considered together.

Nine of the patients were 70 years of age or over. Six were described as cachectic, "losing weight," or in poor general condition. Eight had positive Wassermanns, and another gave a history of previous syphilitic treatment. Eight gave the duration of the lesion as one year or over. Fourteen were secondary cases. Ten of the 34 involved the base of the tongue. In 13 cases the disease had spread beyond the tongue onto the floor of the mouth, tonsil, or epiglottis. Twenty-six of the group had palpable nodes, ten showed bilateral involvement. Some of these were described as hard and fixed, and in one ulceration had taken place. In only 12 of the 34 cases was the diagnosis confirmed by a biopsy. Of these, there were seven Grade 1, two Grade 2, and two Grade 3 tumors, one was not graded. There was one lympho-epithelioma in the group, a Grade 2 tumor with palpable nodes.

Nineteen cases were treated by interstitial radiation alone or in combination with external radiation by the roentgen ray. Fifteen were treated solely by external radiation with the roentgen ray. Six of the latter were sent to homes for incurables after one or more treatments, three of these have died since. One died in the hospital from uremia two days after the insertion of radium needles. Nineteen others died of the disease or committed suicide. One died of apoplexy one year after treatment, and one of "heart trouble" three months after treatment. The one remaining patient is still under observation without evident recurrence. The summary of this group is shown in Table I.

TABLE I

## THIRTY-FOUR INOPERABLE CASES TREATED BY RADIOTHERAPY

Cases	P O D	Died of Disease	Died of Other Cause	Not Traced	Alive under 5 Years	Living over 5 Years
34	1	22	2	8	1	0

From the above analysis, it can readily be seen that, with but a few exceptions, the group was made up of unfavorable or hopeless cases for whom there were no expectations of obtaining a cure. For this reason, they cannot

be considered as comparable to the cases usually reported by radiologists. Furthermore, it would be unfair to attempt to draw any conclusions as to the value of irradiation for such cases, as, in the absence of details as to dosage, *etc*, in the older histories, it is impossible to say whether or not the treatment employed was adequate as judged by present standards. In this connection, it should be explained that it is only within the last five or six years that a well equipped radiotherapy department was established in this hospital under the Department of Surgery.

**NINETY-EIGHT CASES TREATED BY SURGERY OR BY A COMBINATION OF SURGERY AND RADIOTHERAPY**—There were actually 103 cases in this group, but five of these have been excluded, as no pathologic report could be found. One of these is a five year survivor who had an ulcerated tongue lesion with indurated edges,  $1\frac{1}{2} \times 1$  cm in size, and a negative Wassermann reaction. The tongue lesion was destroyed by the actual cautery without a biopsy being taken, and the cervical nodes after removal showed no metastases. The remaining 98 cases were all squamous cell carcinomata.

The following plan has been adhered to in compiling statistics.

Percentages of deaths, survivals, *etc*, are computed upon the total number of cases operated upon, and not merely upon the cases traced.

Only cases which, from their histories, appear to be primary in the tongue, and those in which the clinical diagnosis was verified by a pathologic examination are included.

Cases that died while still in the hospital, following the operation upon the tongue or nodes, are classed as postoperative deaths.

A patient to be classed as a "five year survivor" must have lived free from disease for at least five years from the last operation, or, in the case of recurrence, from the time at which such recurrence was eradicated. Those that recurred or died subsequent to the five year period are entered among the five year survivors.

The term "primary" is used to designate a case which gives no history of previous treatment of the lesion before applying to the hospital for treatment.

The term "secondary" refers to cases in whom previous treatment, such as cauterization, radium treatment, or excision, did not eradicate the disease, or where recurrence followed their use. Patients treated by radium, either in the hospital or elsewhere, who had recurrences, later treated surgically, are grouped with the surgical cases.

In preparing statistical data, the writer has encountered the difficulties so often met with when an attempt is made to study hospital histories. Many of the older records were found to be incomplete, and even among the more recent ones there is frequent omission of information on important points. It has been impossible to obtain complete data from all the histories along any one line of investigation. As a result, the total number of cases upon which statistics are based vary in almost every instance.

**ETIOLOGIC FACTORS**—*Age*—Sixty-one per cent of the patients were be-

tween 50 and 69 years of age, the number being about equally distributed between the fifth and sixth decades. The average age for the entire group is 58.1 years, which is about four years higher than the average given in Lane-Claypon's<sup>2</sup> analysis of the literature. The oldest patient was 79 years old, and the youngest was a man of 31.

TABLE II  
AGE DISTRIBUTION OF NINETY-SEVEN CASES\*

25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-80	Over 80
0	3	7	6	9	15	13	20	11	5	8	0

\* Age not given one case

While a few cases of carcinoma of the tongue have been reported as occurring in children, the youngest on record seems to be a small papillary squamous cell carcinoma in a newborn infant recently reported by Frank, Enfield and Miller.<sup>3</sup>

*Sex*—There are 14 women in this series, giving a ratio of about one woman to seven men (14 per cent), which is above the average of 9.8 per cent obtained by Lane-Claypon from the statistics of a large number of observers.

*Heredity*—Out of 80 of the 98 cases in which the family history is mentioned, only five (6 per cent) give a family history of cancer, which is not of much significance.

*Tobacco*—In 76 histories where the use of tobacco is referred to 13 (17 per cent) denied its use, 27 (36 per cent) used it in moderation, and 35 (46 per cent) indulged to excess, in one the amount used is not mentioned. Seventeen (22 per cent) smoked a pipe, and one (1 per cent) chewed tobacco in addition to smoking.

*Alcohol*—In this series the use of alcohol, when mentioned in the histories, was found to be too indefinite to warrant tabulating.

*Dental Condition*—In 65 histories in which the condition of the teeth is recorded, the teeth in 41 (63 per cent) are described as "bad," "poor," or "irritating." An additional 12 (18 per cent) were wearing plates following removal of poor teeth, and in but 12 (18 per cent) were the teeth described as "good" or "fair." Six patients definitely attributed the tongue lesion to irritation from rough teeth, four to injury from poorly fitting plates or bridge-work, one to biting his tongue, and one to injury by a dentist's emery wheel.

*Syphilis*—In 27 histories there was no reference to the presence or absence of syphilis. Of the remaining 71 cases, a syphilitic history, or a record of antisyphilitic treatment, or a positive Wassermann reaction was noted in 19. This gives an incidence of 27 per cent among the 71 cases in whom the presence or absence of syphilis was noted, or an incidence of 19 per cent for the entire group. The true figures probably lie between 19 and 27 per cent. That syphilis is a very definite etiologic factor in tongue cancer seems without question from the following statistics. Belote,<sup>4</sup> from the University Hospital

of Ann Arbor, found a seropositive syphilitic reaction in 29.3 per cent of 92 cases of cancer of the tongue, distributed as follows: 5.8 per cent among women, and 34.7 per cent among men. According to Fiasei<sup>5</sup> in tongue cancer the syphilitic proportion is 42.3 per cent, and when the malignant lesion affects the dorsum of the tongue the syphilitic incidence rises to 78.3 per cent. Others give higher figures, as Fournier,<sup>6</sup> who found out of 184 tongue cancers evidence of syphilis in 155 (84 per cent). Fournier's cases, however, were taken from patients who were mostly syphilitic. At the other extreme may be mentioned Lund,<sup>7</sup> who found evidence of syphilis in only 17 per cent of 401 tongue cancers, but he also found that of all mouth cancers the highest incidence of syphilis was present in cancer of the tongue.

The association of syphilis with tongue cancer has a marked influence on the prognosis. Lund found that patients in whom syphilis and cancer of the tongue were both present showed a greater proportion of highly malignant tumors than did patients without syphilis. In this group of cases this could not be verified, for the patients with positive Wassermanns were equally divided between the Grade 1 and 2 tumors, and in all of the few Grade 3 cases the Wassermann reaction was either negative or not stated. The results, however, in the cases operated upon with positive Wassermanns were almost invariably fatal. Out of 13 such cases, there were five postoperative deaths, and of the eight remaining six died within 15 months, one within three years, and one is untraced. Thus, of the total number of cases with positive Wassermanns operated upon, 92 per cent are known to be dead. MacGregor,<sup>8</sup> from a study of 25 cases in which there was malignancy of the tongue on a luetic base, expresses the opinion that it is difficult to think of anything but a fatal prognosis where a combination of progressive malignancy of the tongue is present in a syphilitic subject. Meland<sup>9</sup> in a series of 95 intra-oral cancers reports no recoveries among seven cases with a history of syphilis. Lund, out of 40 tongue cases with evidence of syphilis, mentioned one cure (2.5 per cent). Results from radium treatment of tongue cancer complicated by syphilis are, likewise, unsatisfactory, and extensive sloughing of the tissues is not uncommon even though the dose is not excessive.

*Leukoplakia*—Leukoplakia was noted in five cases (5 per cent). This is an unusually low percentage for tongue cancer associated with leukoplakia. In only one of the five cases (20 per cent) was there an associated syphilitic history. Belote states that leukoplakia is found in 20 per cent of the seronegative cases and was found about twice as frequently in seropositive cases of tongue cancer. Lund gives 20 per cent as the proportion of all cases of leukoplakia that show syphilis. Fraser found that the incidence of leukoplakia in dorsal tongue cancer was especially high, *i e*, 90 per cent of the cases being preceded by leukoplakia.

**THE LOCAL LESION**—*Alleged Duration of the Lesion before Admission to the Hospital*—Discarding recurrent or secondary cases previously treated elsewhere, there are 70 histories in which the patients describe the duration as shown in Table III.

TABLE III  
DURATION OF LESION IN 70 CASES

Months	Cases	Years	Cases
Under 3	17 (24.3 per cent)	1-2	10 (14.3 per cent)
3-6	25 (35.7 per cent)	2-3	5 (7.1 per cent)
6-12	11 (15.7 per cent)	3-5	2 (2.8 per cent)

The accuracy of the patient's observation as to duration is open to considerable question in a number of the histories, especially where the lesion was described as being present for a number of years. Some of these were probably benign lesions, the change to malignancy not being recognized by the patient. On the other hand, some lesions described as of very short duration were advanced cancers. It is possible, therefore, that these inaccuracies in the two extremes balance one another. Based on the above statistics, the average duration of the lesion before the patient presented himself for treatment was 7.4 months, close to half the average, natural duration for cancer of the tongue, which is placed by Greenwood (quoted by Lane-Clayton) at 16.4 months. In examining these cases, it was found that private patients came for relief only a little sooner than did the clinic cases. While 60 per cent of the cases presented themselves for treatment with a history of having had the lesion less than six months, approximately 62 per cent of these were private and 57 per cent clinic patients.

For cases that showed cervical metastases, the average length of time the patient had the lesion before applying for treatment was 6.1 months. Raven<sup>10</sup> states that node involvement in tongue cancer occurs in 69 per cent of the cases before six months, 42 per cent before three months, and in 27 per cent before two months. Simmons<sup>11</sup> in a group of intra-oral cancer found that 6.6 months was the average duration before treatment in cases with involved nodes.

*Location of Lesion*—In 92 histories the sites given of the location of the lesion are shown in Table IV.

TABLE IV  
LOCATION OF LESION IN 92 CASES

Tip	4 (4.3 per cent)
Margin, anterior $\frac{2}{3}$	40 (43.5 per cent)
posterior $\frac{1}{3}$	15 (16.3 per cent)
Dorsum	13 (14.1 per cent)
Base	5 (5.4 per cent)
Under surface	10 (10.8 per cent)
Whole tongue	5 (5.4 per cent)

*Size of Lesion*—Classification under size is made difficult from the lack of uniformity in the descriptive terms employed. At times the lesion is described as small, medium, or extensive, and in other instances its actual size in centimeters or inches is given. Classifying as small all lesions of 1 cm. or under, as medium those between 1 and 2 cm., and as extensive those

over 2 cm and those that have spread beyond the tongue to other parts of the oral cavity, the following figures were obtained in 83 cases where the lesion was described (Table V)

TABLE V  
SIZE OF LESION IN 83 CASES

0-1 cm (small)	13 (15.6 per cent)
1-2 cm (medium)	17 (20.5 per cent)
Over 2 cm (extensive)	53 (63.8 per cent)

*Type of Growth*—In 83 cases the type of growth is shown as in Table VI

TABLE VI  
TYPE OF GROWTH IN 83 CASES

Papillomatous	9 (10.8 per cent)
Tumor	11 (13.2 per cent)
Ulcerative	63 (75.9 per cent)

The small percentage (10 per cent) of a relatively favorable type of growth (papillomatous) and the high percentage (75 per cent) of the more malignant ulcerative tumors is noteworthy

*Grading of the Tumor*—Ninety-two of the 98 cases are graded according to Broder's classification. There were 50 (54 per cent) Grade 1, 38 (41 per cent) Grade 2, four (4 per cent) Grade 3, and no Grade 4 tumors

Comparison of groups of cases each graded by different pathologists is not of great value, as there may be considerable variation through a difference of interpretation of the microscopic picture. This fact is well illustrated when the figures in this series and those given by Meland are compared with those of other observers. In this series there are 95 per cent Grade 1 and 2 and only 4 per cent Grade 3 tumors. Meland's figures based on 47 tongue cases, of which 19 are graded, are somewhat similar: five (twenty-six per cent) Grade 1, 12 (sixty-three per cent) Grade 2, one (five per cent) Grade 3, and one (5 per cent) Grade 4. Others report a much higher percentage of Grade 3 and 4 tumors. Pfahler and Vastine,<sup>12</sup> in 186 tongue cases treated by radiotherapy, found 53 per cent Grade 3 and 4. Berven,<sup>13</sup> from his tongue cancers, reports 46.15 per cent Grade 3 and 5.12 per cent Grade 4 tumors. Judd and Phillips,<sup>14</sup> from the Mayo Clinic, found more than 50 per cent of tongue cancers were Grade 3 and 4 (Broders). Blair, Brown, and Womack<sup>15</sup> found that out of 33 tongue cases the Grade 3 and 4 tumors each formed 33 per cent of the total.

The grading of the primary growth, as will be shown later, did not have much influence on the prognosis. Furthermore, it did not prove of great value as a guide to the presence or absence of metastases, as shown in Table VII.

*CONDITION OF THE NODES*—Of the 98 cases, 59 showed palpable nodes on admission, 22 (38 per cent) of which were bilateral. In 23 histories it is stated

TABLE VII

## INCIDENCE OF METASTASES IN RELATION TO GRADE OF TUMOR

	Cases	Nodes Not Involved	Nodes Involved
Grade 1	36	19 (52.8 per cent)	17 (47.2 per cent)
Grade 2	33	16 (48.5 per cent)	17 (51.5 per cent)
Grade 3	4	3 (75 per cent)	1 (25 per cent)

there were no palpable nodes, and in 16 instances no mention is made of their presence or absence. Out of 80 cases in which nodes were operated upon and examined microscopically, 38 (47.5 per cent) showed metastases. Of 48 cases *with palpable nodes* which were examined microscopically, 23 (48 per cent) showed no metastases, of 18 cases where it was stated *no nodes were palpable*, seven (39 per cent) showed metastases, and out of 14 cases where the *nodes were not mentioned*, six (42 per cent) showed metastases. In other words, one-half of those with palpable nodes and over one-third of the cases without palpable nodes, or where the presence or absence of nodes was not mentioned, showed involvement on microscopic examination.

Phillips,<sup>16</sup> in a series of 319 *buccal* carcinomata, reports that out of 59 with clinical metastases, 22 (37.3 per cent) were negative microscopically, and of 31 cases with no clinical metastases, 16 (51.6 per cent) showed carcinoma on microscopic examination. In a group of *oral* cancers, Simmons<sup>17</sup> found that out of 22 cases with clinically palpable nodes, ten (45 per cent) showed no cancer, and of 20 cases of nonpalpable nodes, seven (34 per cent) proved to be cancerous. It is thus evident that the usual classification of the condition of the nodes, into clinically palpable and clinically nonpalpable, is not a reliable index of the presence or absence of metastases. As a more accurate method, Lund and Holton<sup>18</sup> suggest the division of the nodes into "small" and "large" nodes. Under "small" nodes they include the following cases described as small, not enlarged, negative, up to 1 cm. in size, or not mentioned. All others they include in the large node group. Reclassifying Simmons' cases into these groups, they found that about the same number of cases with small nodes showed metastases as were negative, while 100 per cent of the cases classed as "large" nodes proved to be metastases.

RESULTS OF TREATMENT—Of the 98 cases upon which the foregoing study is based, 88 were treated by surgery and ten by a combination of radiotherapy and surgery. Seventy-three were treated prior to 1931 and 25 since that time. Included among the total treated are 25 private patients, and the writer is greatly indebted to Drs. George H. Semken, Franz J. A. Torek, Henry H. M. Lyle, Joseph E. King, Robert H. Kennedy, and William F. MacFee for permission to include them in this study. The 73 clinic cases were treated by more than 15 different surgeons as well as their assistants, so that the results can be considered as representing the work of a fairly large hospital group. A summary of the cases treated with division into two groups, prior to 1931 and since 1931, follows. In Tables VIII and IX are included all cases operated upon, whether primary or secondary, with and



without metastases, and those upon whom palliative operations only were performed

TABLE VIII

TABLE IX

GROUP OPERATED UPON BETWEEN 1917 AND 1930		GROUP OPERATED UPON BETWEEN 1931 AND 1935	
Postoperative deaths	22 (30.1 per cent)	Postoperative deaths	4 (16 per cent)
Recurred and lost, or died from recurrence or with disease	30 (41 per cent)	Recurred and lost, or died from recurrence or with disease	7 (28 per cent)
Died from other causes	1 (1.4 per cent)	Died from other causes	1 (4 per cent)
Untraced	5 (6.8 per cent)	Untraced	1 (4 per cent)
Surviving five years or more	15 (20.5 per cent)	Surviving less than five years	12 (48 per cent)
Total cases	73	Total cases	25

ANALYSIS OF CASES OPERATED UPON BETWEEN 1917 AND 1930—The 1917-1930 group only is used as a basis for computing "cures," the results from various types of operation, *etc.* Seventy of these cases were treated by surgery and three by a combination of radiotherapy and surgery. In 42 of the 73 cases, the disease was limited to the tongue, in 14 it had involved also the floor of the mouth, in five, the tonsil, in three, the tonsil as well as the floor, in two, the superior portion of the larynx, and in two, the lower jaw. The other five could not be classified on account of poor histories. Thus, in 26 out of the 73 cases (36 per cent), the disease had already spread locally beyond the tongue. Also in 20 of the 42 cases (48 per cent) in which the disease was limited to the tongue, metastases were found in the cervical nodes at operation. We find, therefore, that almost two-thirds of the cases could be classified as well advanced. Also among the above were 17 cases that still had the disease, or were definite recurrences following some form of previous treatment, such as cauterization, radiotherapy, or an incomplete operation.

*Cases Treated by Surgery*—In the surgically treated cases, the tongue lesion was removed by surgical dissection as a rule, in other instances the actual cautery, electrocoagulation, or the electrocautery was employed. An intra-oral operation was performed in 42 instances, after division of the lower jaw in 11 cases, and through the neck in nine instances, and once after division of the cheek. For the removal of the cervical nodes the upper cervical node dissection as described by Dr. George H. Semken<sup>19</sup> was employed in most of the cases. Briefly, this consists of a block dissection of the submental, submaxillary, parotid, carotid, and posterior cervical nodes to below the level of the omohyoid crossing, together with the platysma and all fatty tissue, the submaxillary gland, and the lower pole of the parotid gland. Unless involved, the internal jugular vein and the sternomastoid muscle are not removed. In some cases, notably where a bilateral node dissection was performed in one stage, a variation of this standard upper node dissection was

used As modified, the operative field did not extend as low or as far posteriorly as in the typical neck operation In eight instances, it is recorded that the upper node operation was supplemented by a supraclavicular node dissection on the affected side In two of these, the supraclavicular operation was bilateral Our present procedure for treatment of the nodes, if the patient is in good physical condition, is preferably a complete bilateral node dissection down to the clavicle

Postoperative radiation of the cervical region has not been employed as a routine It appears to have been used in but 13 cases, none of whom have survived five years Our feeling is that it is not of advantage to employ it In the first place, if the removal of the cervical nodes is thorough, it is not necessary, in the second place, if recurrence takes place, the patient has a better prospect of obtaining some benefit from radiation if it has not been employed previously

*Results According to the Type of Operation*—There were six variations of operative procedure applied to the 70 cases treated by surgery

(1) Simple excision of the tongue lesion (a questionable procedure for any tongue cancer, except as a palliative measure)

(2) Excision of the tongue and nodes of the opposite side of the neck in one stage, and excision of the nodes of the affected side at a later date This is the ideal method of dealing with cases in good physical condition and with tongue lesions not requiring too extensive an operative procedure

(3) Excision of the tongue and nodes of one or both sides, each in a separate stage This type is, thus, either a two or three stage procedure It is used principally in cases where the tongue lesion requires so extensive an operation that to add a neck dissection, as in procedure 2 above, would be more than the patient could withstand with safety

(4) Excision of bilateral nodes in one stage and the tongue lesion at a later stage

(5) Excision of the tongue and the nodes of the affected side at one operation

(6) Excision of the tongue and a bilateral node operation in one stage

The last three procedures, on account of the high operative mortality attending them, have not been employed since 1929

For the purpose of drawing conclusions as to the relative risk, percentage of cures, etc., from these operations, they are tabulated in detail in Table X, and are divided into complete and incomplete operations In the latter group are placed a number of operations which from the history and preoperative findings obviously required more thorough surgery than was actually accomplished, the operation not being completed, either because the patient did not survive the first stage of the operation, or else refused further treatment, or because the condition was found to be inoperable

The two cases in which excision of the primary lesion only was performed had small papillary tumors, showing early malignant changes, for which local excision was evidently considered sufficient One was followed

# CANCER OF THE TONGUE

TABLE X

SUMMARY OF 70 CASES TREATED SURGICALLY BETWEEN 1917 AND 1930

Type of Operation	Cases	P O D	Recurred and Lost, or Died	Died Other Causes	Not Traced	Five Year Survivals
Excision of tongue lesion only	2	0	1 (50 per cent)	0	1 (50 per cent)	0
Excision of tongue and nodes of opposite side, one stage, nodes of same side later	13	3 ( 23 1 per cent)	3 (23 1 per cent)	0	0	7 (53 8 per cent)
Complete	11	1 ( 9 1 per cent)	3 (27 2 per cent)	0	0	7 (63 7 per cent)
Incomplete	2	2 (100 per cent)	0	0	0	0
Tongue and nodes each operated upon in a separate stage (a two or three stage operation)	19	6 ( 31 5 per cent)	7 (36 8 per cent)	1 (5 3 per cent)	3 (15 8 per cent)	2 (10 6 per cent)
Complete	13	1 ( 7 7 per cent)	6 (46 1 per cent)	1 (7 7 per cent)	3 (23 1 per cent)	2 (15 4 per cent)
Incomplete	6	5 ( 83 3 per cent)	1 (16 6 per cent)	0	0	0
Bilateral nodes first stage, tongue later	11	3 ( 27 2 per cent)	7 (63 6 per cent)	0	0	1 ( 9 1 per cent)
Complete	9	1 ( 11 1 per cent)	7 (77 7 per cent)	0	0	1 (11 1 per cent)
Incomplete	2	2 (100 per cent)	0	0	0	0
Tongue and nodes of same side in one stage	16	7 ( 43 7 per cent)	6 (37 4 per cent)	0	0	3 (18 7 per cent)
Tongue and bilateral nodes in one stage	6	3 ( 50 per cent)	2 (33 3 per cent)	0	0	1 (16 6 per cent)
Palliative operations	3	0	2 (66 6 per cent)	0	1 (33 3 per cent)	0
Totals	70	22 ( 31 4 per cent)	28 (40 per cent)	1 (1 4 per cent)	5 ( 7 1 per cent)	14 (20 per cent)

for over two years without recurrence and was then lost. Another had a local recurrence in two years which was excised, and returned with a second recurrence four years later, and was then lost track of.

Exclusive of the above group, the lowest operative mortality occurs in the three groups where the operations on the tongue and the nodes of the same side were performed in separate stages. In these groups the operative mortality ranges from 23 1 to 31 5 per cent for the combined "completed" and "incompleted" cases, and from 7 7 to 11 1 per cent in the completed cases. In the two groups where the tongue and nodes of the affected side of the neck were operated upon at the same time, the mortality ranges from 43 7 to 50 per cent. The lesson this teaches is that when the operation is performed in such a way as to leave a communication between the mouth and the freshly opened cellular spaces of the neck, the operative risk is enormously increased. Fraser gives 83 per cent as the mortality of the stage operations against 52 6 per cent mortality for the simultaneous mouth and neck operation. Blair and Brown<sup>20</sup> give a 34 per cent mortality for the combined neck and tongue operation. Fischel<sup>21</sup> states that the results in tongue cases were poor, both as to postoperative deaths and cures, when the intra-oral and neck dissections were combined, but where the neck operation was performed two weeks later the mortality was low.

Under palliative operations, three cases are included. One patient, after a cervical node operation had been done, was deemed to be inoperable, and the tongue lesion was not removed. He received some postoperative radiation and died in six months. Another refused to have the cervical nodes removed after excision of the tongue lesion and died in seven months. The third, a man of 69, with bilateral palpable cervical nodes, had his tongue lesion first removed by the cautery and four months later by surgical excision, and was then lost track of. It is probable that some of the cases placed in the incomplete group, where the tongue and nodes were removed separately, belong among these palliative operations, but, on account of the lack of details in their histories, they have not been included among the latter.

*Cases Treated by Combined Radiotherapy and Surgery*—A summary of three cases so treated is given in Table XI.

TABLE XI

SUMMARY OF CASES TREATED BY COMBINED RADIOTHERAPY AND SURGERY, 1917-1930

	Cases	P	O	D	Recurred and Lost, or Died	Died Other Causes	Not Traced	Five Year Survivals
Radium to tongue, node operation later	1	0	0			0	0	1 (100 per cent)
Palliative operations and radium	2	0	2	(100 per cent)	0	0	0	
Total	3	0	2	(66.6 per cent)	0	0	0	1 (33.3 per cent)

The one case whose tongue lesion was treated by implantation of radium followed by a unilateral node dissection is a seven year survival. The nodes on examination were found to be carcinomatous. The other two were inoperable and are classed under palliative operations. In one, the external carotid artery was ligated and part of the tongue was removed, followed by implantation of radium. The other was given external radiation and both lingual arteries were tied. One died within three months, and the other within ten months. The results in this group, with 33.3 per cent five year survivals, are better than those obtained from surgery alone, but the cases are too few to warrant drawing definite conclusions.

*Results Where (1) the Tongue Operation Preceded, or (2) Followed the Node Operation, and Where (3) There was a Simultaneous Tongue and Node Operation*—In order that the "tongue first" group and the "node first" group may be comparable to the simultaneous tongue and node group, cases that died from the first stage of operations where the tongue or nodes were removed first are omitted (Table XII).

The best results, both as to five year survivals and recurrences, were obtained where the tongue operation preceded that on the nodes of the affected side, and the worst results are seen in the group in which the nodes of the affected side were removed first. In spite of this, removal of the nodes first may be necessary in cases of rapidly developing lymphatic involvement, where

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TABLE XII

SUMMARY OF CASES OF (1) TONGUE REMOVAL FIRST, (2) NODE REMOVAL FIRST, AND (3) SIMULTANEOUS REMOVAL OF TONGUE AND NODES

	Cases	P O D	Recurred and Lost, or Died	Died Other Causes	Not Traced	Five Year Survivals
Tongue operation first followed by node operation later	15	1 ( 6 7 per cent)	5 (33 3 per cent)	1 (6 7 per cent)	0	8 (53 3 per cent)
Node operation first, tongue op- eration later	18	1 ( 5 5 per cent)	12 (66 6 per cent)	0	3 (16 6 per cent)	2 (11 per cent)
Simultaneous tongue and node operation	22	10 (45 4 per cent)	8 (36 3 per cent)	0	0	4 (18 2 per cent)

the delay caused by operating upon the tongue first might result in the nodes becoming inoperable. The simultaneous tongue and node operation, while giving better results as to five year survivals and recurrences than the node first group, had a mortality rate of 45 4 per cent. Frasei, in his series of *mouth and tongue cancer*, states that he obtained his best results as to recurrences in a simultaneous tongue and node operation. His results were about the same whether the tongue or nodes were removed first.

*Results According to the Completeness of Removal of the Cervical Nodes*—The nodes of the affected side only were excised in 36 instances, while a bilateral node operation was performed on 27 cases. The percentage of five year survivals from the bilateral node operation is more than double that obtained when the unilateral operation only was performed, while the percentage of recurrences and deaths after leaving the hospital is about the same whether a bilateral or unilateral operation was performed (Table XIII). The high postoperative death rate from the unilateral node operation is misleading in that it would appear to be a more dangerous procedure than a bilateral operation. This high percentage (40 7 per cent) is due to the fact that seven of the 11 deaths from the unilateral node operation occurred in cases where the tongue and nodes of the same side were operated upon at one sitting.

The results where a unilateral or bilateral node dissection was supplemented by a supraclavicular node operation are even better than in the other two groups, with 50 per cent five year survivals. The fact that there were no deaths from this procedure is noteworthy, but it should be stated in three of the eight cases, the supraclavicular dissection was performed in a separate stage from the upper node dissection. Prior to 1931, the supraclavicular node operation was performed in only eight (12 per cent) of the 63 neck dissections. Since that time, it has been employed in seven (58 per cent) out of 12 neck operations.

*Postoperative Deaths*—There were 26 postoperative deaths among the 98 cases, giving a mortality rate of 26 1 per cent for all cases, and 28 4 per cent for those treated solely by surgery. No cause is assigned for 14 of the deaths. Of the remaining 12, five died from pneumonia, two from pulmonary

TABLE XIII

## RESULTS ACCORDING TO THE COMPLETENESS OF CERVICAL NODE OPERATION

	Cases	P O D	Recurred and Lost or Died	Died Other Causes	Not Traced	Five Year Survivals
Unilateral node operations	27 <sup>†</sup>	11 (40.7 per cent)	10 (37.7 per cent)	0	2 (7.4 per cent)	4 (14.8 per cent)
Bilateral node op erations	36	7 (19.4 per cent)	16 (44.4 per cent)	1 (2.8 per cent)	1 (2.8 per cent)	11 (30.5 per cent)
Complete node operations on the affected side	3 <sup>†</sup>	0	4 (50 per cent)	0	0	4 (50 per cent)

\* One case in whom the tongue was treated by radium and the nodes were removed is included

† All of these cases, of course, are from among the above groups in which the nodes of one or both sides were removed

edema, one from lung abscess, one from infection, one from shock one from hemorrhage, and one from suffocation

The 28.4 per cent operative mortality for the entire group of 88 cases treated by surgery alone is high compared with the statistics on similar cases from other clinics. Butlin<sup>22</sup> in 197 operations had only a 10 per cent mortality, Haitmann<sup>23</sup> reports 10 per cent mortality. Blair, Brown, and Womack had an operative mortality of 26.9 per cent from their tongue operations. Fischel<sup>24</sup> in 59 cases had a 20 per cent mortality. Moure and Martin<sup>25</sup> out of 65 cases lost 16 (24.6 per cent) postoperatively. Some other figures are lower, but, for combined early and late cases, the postoperative mortality probably ranges around 20 per cent.

The large number of fatalities in the simultaneous operations on the tongue and nodes of the same side, with its 45.4 per cent mortality rate, partly accounts for these high percentages. Since the year 1929, no one stage operations on the tongue and nodes of the same side and no bilateral node operations in one stage have been performed, and the postoperative death rate among the surgical cases for the five year period since then (1931-1935) is 16.7 per cent. In the 14 year period prior to this (1917-1930), the postoperative death rate was 31.4 per cent, showing an improvement of almost 50 per cent in results since operative methods with a recognized high mortality rate were abandoned. Another factor that may have a bearing on the high postoperative death rate is the age of some of these cases. While six of the 26 deaths were in patients 50 years of age or under, the average age of the remaining 20 was 63.4 years. The ages of six of the latter ranged between 68 and 79 years. Applying our present principles of treatment to the above group, we probably would not treat by surgery these old patients with extensive lesions requiring very radical operations for complete removal. For such cases, radiotherapy would offer a better chance for prolongation of life and possibly control of the disease to such an extent that the patient could pass his few remaining years in comparative comfort.

*Recurrences and Deaths after Discharge from Hospital*—Thirty of the 73 cases (41 per cent) recurred or died after discharge from the hospital.

Twelve (40 per cent) of these had involvement of the nodes when operated upon. On the charts of 11 patients, it is stated merely that they died, and on three that they died from the disease. Sixteen others recurred and either died, committed suicide, or were lost. Five of these recurrences were local, four were in the lymph nodes, and in three the recurrence was both local and in the neck. In the remaining four histories, it is simply stated that there was a recurrence. All but two of the 16 recurrences (87 per cent) took place within the first year following the operation. There were, in addition, two local recurrences and one case of cervical metastases which are not entered in the recurrence column as they are among the five year survivals. The two local recurrences after further surgical treatment are still alive and free from disease over five years. The case of cervical metastases, after remaining well and free from disease nine years, developed supraclavicular nodes and died a year later.

Examination of the neck recurrences revealed three cases of cervical metastases, without local recurrence, in which at the original upper node operation the pathologic examination showed only hyperplasia of the nodes. In two of the cases, the metastases occurred in the supraclavicular region of the affected side (one nine years after operation), in the third, in the supraclavicular region of the opposite side. A fourth case showed, three months after removal of hyperplastic nodes from one side, involvement of the nodes of the opposite side and recurrence below the end of the horizontal incision on the side originally operated upon. As there were 36 cases of hyperplastic nodes operated upon, over 10 per cent of them developed metastases either on the same side below the limits of the original neck dissection or upon the opposite side without the upper cervical nodes showing involvement. In other words, there was an error of around 10 per cent in the pathologic diagnosis due to the impossibility of examining every portion of the specimen. Brown<sup>26</sup> found that out of 140 neck dissections for carcinoma of the mouth, there were 13 instances where the pathologic report of the absence of cancer did not coincide with the clinical course. Among his cases, the longest period that carcinoma lay dormant in the nodes was seven years.

These cases serve as an argument for the complete removal of the lymph nodes to the clavicle from both sides of the neck where the condition of the patient will permit. While certain areas of the tongue are drained by definite groups of lymphatics, it is well recognized that metastases from tongue cancer may follow peculiar courses, not infrequently showing in the deep carotid nodes, or in those immediately above the clavicle, as for example, when the anterior portion is involved, without there being involvement of the superficial groups. More rarely, metastases occur first upon the side of the neck opposite to that upon which the lesion is situated.

*Died from Other Causes*—The one case in this group died a short time after operation, free from disease, from erosion of the carotid artery, the result of destruction of the thin neck flap by postoperative roentgen therapy.

*Cases Not Traced*—When this work was begun, the fate of many cases

was unknown, and it seemed an almost impossible task to hope to obtain data on some of the older ones. However, through the excellent work done by the Social Service Department, the results in all but five of the 1917-1930 group are now known. One of these had cervical metastases when operated upon, so it can be safely assumed that he had died. Up to the present time, information as to what happened to the other four is entirely lacking.

*Survivals of Five Years and Over*—There are 15 five year survivals (20.5 per cent) from all operations, or 20 per cent for all types of cases treated by surgery alone. The distribution of the survivors is shown in Table XIV.

TABLE XIV

## DISTRIBUTION OF THE SURVIVING CASES

5 to 6 years	3 cases
6 to 7 years	1 case
7 to 8 years	2 cases
8 to 9 years	1 case
9 to 10 years	4 cases
Over 10 years	4 cases

Two of the above have since died. One, after nine years of freedom, developed supraclavicular metastases. The other died of a "heart attack" after seven years.

The results as to five year survivals among the private cases were very much better than among the clinic patients. There were 36.4 per cent five year survivals in the former group and 13.7 per cent in the latter. It might be assumed that these better results were due to the fact that private patients had earlier lesions. This is not the case, however, for, as already shown, among the cases that presented themselves for treatment with lesions of under six months' duration, there were only 5 per cent more private patients than clinic patients, while out of the cases that showed cervical metastases, 36 per cent were private and 35 per cent clinic cases. The explanation probably is that the private patients were in better physical condition for extensive operations and came under the care of more skilled operators. Furthermore, none of the cases in which syphilis was present occurred among the private patients.

Results as to five year survivals considered from the standpoint of whether the case was primary or secondary, and whether the cervical nodes

TABLE XV

## RESULTS IN PRIMARY AND SECONDARY CASES WITH AND WITHOUT METASTASES

	Cases	Five Year Survivals
Primary cases, nodes not involved	30	10 (33.3 per cent)
Secondary cases, nodes not involved	7	2 (28.5 per cent)
All cases, nodes not involved	37	12 (32.4 per cent)
Primary cases, nodes involved	22	2 (9.1 per cent)
Secondary cases, nodes involved	4	1 (25 per cent)
All cases, nodes involved	26	3 (11.5 per cent)



were uninvolved or involved are shown in 63 cases in which the nodes were subjected to pathologic examination (Table XV)

From the above, whether the case was primary or secondary seems to have little bearing on the result. In fact, the results were a little better in the secondary cases with 27 per cent five year survivals against 23 per cent in the primary cases. *Of prime prognostic importance is the presence or absence of cervical metastases.* Without metastases, there were 32.4 per cent five year survivals, while with metastases, the five year survivals fell to 11.5 per cent. Likewise, the size and the grade of the tumor had little prognostic value when the primary lesion was treated surgically (Tables XVI and XVII)

TABLE XVI  
RESULTS ACCORDING TO THE SIZE OF THE LESION

Size	Cases	Five Year Survivals
Small (0-1 cm )	11	2 (18.1 per cent)
Medium (1-2 cm )	11	2 (18.1 per cent)
Large (2 cm and over)	37	6 (16.2 per cent)

TABLE XVII  
RESULTS ACCORDING TO THE GRADE OF THE TUMOR

Grade	Cases	Five Year Survivals
1	40	8 (20 per cent)
2	28	4 (14.3 per cent)
3	2	1 (50 per cent)
4	0	0

There have been many excellent papers on the results of the treatment of tongue cancer published during the last five years, but in many cases it has been impossible to use the statistics on account of the manner in which the material was presented or from the fact that survivals of from under one year upward were sometimes included with the five year survivals in computing the results. From some of these reports the writer has attempted to figure out the five year survivals, but, in each instance, it is indicated when such percentages are used. From clinics where surgery was mainly employed the result are as follows. From the Barnard Free Skin and Cancer Hospital, 1906-1925, Fischel reports three (5 per cent) out of 59 cases as living and well five years (this group includes all types of cases). Gask's<sup>27</sup> statistics from St. Bartholomew's Hospital show 17.1 per cent five year survivals. Moure and Martin, in 57 cases of histologically confirmed cancer of the tongue, had 12 five year cures (apparently all types of cases are included, and there are also included some cases treated during the last five years, so that the actual percentage of five years survivals cannot be determined). New and Figg,<sup>28</sup> from the Mayo Clinic, in 162 cases report 58 (37.2 per cent) five year survivals from all types of cases. Without metastases they had 50 per cent five year survivals and with metastases 14.3 per cent (these figures,

however, are based on the cases traced and would be slightly lower if based on all the cases treated) Pattison<sup>29</sup> reports 28 cases of microscopically verified tongue cancer, operated upon by diathermy with seven (25 per cent) survivals of over five years. Of these, 13 had cervical metastases, with no five year survivals, and without metastases there were 49 per cent five year survivals. From the Collis P. Huntington Memorial Hospital and the Massachusetts General Hospital, from 1918 to 1924, from a series of 763 oral cancers, Simmons reports, in 42 primary cases of tongue carcinoma without evidence of lymphatic metastases, 12 (29 per cent) five year "cures."

Among those using radiation alone, or as the principal form of treatment, for the tongue lesion, the method of treating the cervical nodes varies considerably. In the majority of clinics, nonpalpable nodes are treated by external radiation or the radium collar. Palpable nodes in some clinics are treated by external radiation or radium, and a block dissection if they do not disappear. Others use either a block dissection for operable nodes, followed by the radium collar if the nodes are involved, or interstitial radium implants in the involved nodes. Results from some of the clinics where the above methods are used are as follows. Cade,<sup>30</sup> from the Westminster Hospital, reports from 18 tongue cancers two (11 per cent) five year survivals. He further states that of these 18, 13 had palpable nodes, seven of which were inoperable. Quick,<sup>31</sup> from the Memorial Hospital, out of 473 cases reports 39 cases free from disease from five to 12 years (the percentage of five year survivals cannot be determined, as in the 473 cases are included patients treated less than five years previously). Regaud's<sup>32</sup> statistics show the five year survivals for different portions of the tongue. Combining these figures, there were 58 (17.6 per cent) five year survivals from 330 cases of all types. From the Radiumhemmet in Stockholm, Berven reports separately for the purpose of comparison, for the years 1916 to 1921 and from 1922 to 1926. Combining his figures, on 104 cases from 1916 to 1926, there were 33 (32 per cent) five year "cures" for all cases. These were distributed as follows: Group 1 (without metastases), 60 cases with 32 (50 per cent) five year "cures." Groups 2 and 3 (with operable and inoperable metastases), 44 cases and one (2 per cent) five year "cure."

Berven's<sup>33</sup> later figures, for 1916 to 1928, give in 141 cases of tongue cancer 40 (28 per cent) five year "cures." From the Curie Foundation Roux-Berger,<sup>34</sup> in a series of 386 tongue cancers, reports the results separately for different portions of the tongue. Combining his figures, there were out of 382 microscopically verified cancers 18 per cent five year "cures." These were distributed according to their extent as follows: Under 2 cm., 55 cases with 25 (45 per cent) five year "cures." Over 2 cm., 327 cases with 46 (14 per cent) five year "cures." From the Liège University, Deliez and Desaiwe<sup>35</sup> give results in 52 tongue cancers for periods from six months to eight years. In this series there were five five year survivals. Pfahler<sup>36</sup> reports 16 (26.2 per cent) five year survivals.

ANALYSIS OF CASES OPERATED UPON BETWEEN 1931 AND 1935—In the group of 25 cases treated since 1930, there were four postoperative deaths, two of which occurred following palliative operations for extensive tongue lesions. In the 18 cases treated surgically, a stage operation was performed in all in which the tongue and nodes were operated upon, and it is noteworthy that the postoperative death rate is 16.7 per cent, an improvement of nearly 50 per cent over the mortality rate in the earlier group.

Of the seven cases that recurred, or died with the disease, one was treated surgically. This latter case, after a node operation had been performed, was felt to be inoperable, and the tongue lesion was not removed. The patient died from the disease in three months. The other six cases were from a group of seven in which the tongue lesion was treated by implantations of radium. In none of the six was there a permanent disappearance of the lesion. The seventh case, a Grade 3 tumor, is of too recent a date to determine the result. One of the seven cases was not graded, five had Grade 1 tumors, and one had a Grade 2 tumor. Four had positive Wassermanns and in three the lesion is described as extensive. All recurrences took place under two years. The results in these cases are very poor. Out of a total of 11 cases treated by a combination of radium and surgery (one patient, after recurrence, was treated by surgery and is now included among the surgical cases), there is but one patient whose tongue lesion remained free from disease after the use of radium. Reports from other sources show that a temporary disappearance of the lesion should be looked for in about 70 per cent of the cases, but that a certain number can be expected to recur. Fitzwilliams<sup>37</sup> states that a 75 per cent temporary result is obtained locally, and a 60 per cent permanent result. Cade, out of 169 tongue cases, reports the disappearance of the growth in 126 (74 per cent) and recurrence in 43 (25 per cent).

There are 12 cases (46 per cent) alive and free from disease less than five years. These are distributed as follows: One over three years, two over two years, one over one year, and eight under one year.

SUMMARY—(1) Ninety-eight cases of microscopically confirmed cancer of the tongue form the basis of this report.

(2) Two-thirds of the cases were advanced cancers in the sense of having spread beyond the limits of the tongue or showing node involvement. Eighty-eight were treated surgically, and ten by a combination of radium and surgery.

(3) Neither the size nor the grade of the tumor proved of much prognostic value among the cases treated surgically.

(4) Ninety-two per cent of the cases with positive Wassermanns operated upon died either postoperatively or within three years.

(5) The operative mortality for the entire group amounted to 26.1 per cent, and 28.4 per cent for those treated by surgery alone. In the last five years, the postoperative death rate was 16.7 per cent. The lowest mortality rate occurred where a "stage" operation was performed. Among the simultaneous tongue and node operations, the postoperative mortality ranges from 43 to 50 per cent.

(6) Twenty per cent of all cases treated by surgery survived five years or over. Without node involvement, there were 32.4 per cent five year survivals, and with node involvement 11.5 per cent five year survivals. Out of three cases treated by a combination of radium and surgery, there was one (33 per cent) five year survival.

(7) The best results as to five year survivals and recurrences were obtained where the tongue was removed first. The next best results followed a simultaneous tongue and node operation. The poorest results were obtained in those cases where the node operation preceded that upon the tongue.

(8) The results as to five year survivals are over twice as favorable from a bilateral node operation when compared to those obtained from an excision of the nodes of the affected side only, and they were even better when there was a complete node removal down to the clavicle.

(9) Five year survivals among the private patients were almost three times greater than among the clinic patients.

(10) Postoperative radiation was not used as a routine. There were not a sufficient number of cases in which it was employed to form any conclusion as to its value.

(11) In over ten per cent of the cases following removal of hyperplastic nodes by an upper node dissection, where there was no local recurrence, cervical metastases occurred later on the same side of the neck in the supra-clavicular region or upon the opposite side of the neck.

(12) Among the cases treated by radium and surgery, the results as to the permanent eradication of the tongue lesion were very poor. Where radium was used for the primary lesion, a permanent disappearance of the cancer was effected in only ten per cent.

#### CONCLUSIONS

In the treatment of tongue cancer no one method should be used to the exclusion of others. Surgery and radium each have their place, and the selection of the form of treatment in individual cases must depend upon the condition of the patient, the extent and location of the primary lesion, and the radiosensitivity of the tumor. While excellent results are reported by some radiologists from the routine treatment of the primary lesion by radium, our own preference, at the present time, is for a wide surgical removal of operable lesions preferably by the diathermy knife. For very radiosensitive lesions, radium should be tried before resorting to surgery. Extensive lesions in the posterior part of the tongue often may be eradicated by electrocoagulation and the use of radium with less mutilation than where surgery alone is employed. Cases in which radium fails to cause a disappearance of the lesion should be treated surgically. Whether radium or surgery is employed in the treatment of the tongue lesion, it is felt that eradication of the primary lesion should be effected, as a general rule, before removal of the cervical nodes is attempted.

An objection to the surgical treatment of tongue cancer is the operative mortality. If operative procedures with a recognized high death rate are

avoided and obviously poor surgical risks are refused operation, this should be well under 20 per cent for the combined tongue and node operation. That the use of radium is not unattended by some fatalities as the result of radium-necrosis, infection, and hemorrhage seems certain, but it is impossible to say just what the percentages are, as radiologists apparently do not list such cases as postoperative deaths.

When it comes to a question of the efficiency of surgery and radiation in the treatment of the cervical nodes, comparison of results from the two methods are useless, because in radiated cases cancerous involvement of the nodes is rarely confirmed by pathologic examination, and results on the treatment of "palpable nodes" mean nothing. As already pointed out, the presence or absence of palpable nodes is not to be depended upon as a reliable guide to the presence or absence of metastases. Tongue cancer rapidly metastasizes, and prognosis depends more than anything else upon the presence or absence of node involvement. Without node involvement, we should expect over 30 per cent five year "cures" in unselected cases, with node involvement the five year "cures" probably average well under 10 per cent. Successful treatment must depend upon keeping ahead of the disease, or, in other words, preventing extension of the disease to the neck. Thorough surgical removal of operable cervical nodes, whether palpable or not, seems a more rational procedure for accomplishing this than treating necks by external radiation, which is of questionable value except in the presence of very radiosensitive metastases, and then performing a neck dissection or using radium implants after metastases are thought to be present. For inoperable nodes, however, radiotherapy is of some value in prolonging life and occasionally producing a cure in the more radiosensitive forms.

The average duration from the onset of symptoms to the time the patient seeks relief with tongue cancer is still much too long to expect good results from treatment. This seeming neglect on the part of the patient is difficult to understand when it is considered that the mouth is one of the cavities of the body most accessible to inspection, and that cancers of the tongue are usually preceded by abnormal changes which are present for a considerable time before malignancy develops. Until the public is educated regarding the importance of mouth hygiene and the necessity of obtaining medical advice promptly when unusual conditions develop and persist about the mouth or tongue, the percentage of "cures" probably will continue to remain low.

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#### REFERENCES

- <sup>1</sup> Quick, Douglas. Management of Cancer of the Mouth and Cervical Lymph Nodes. *Am J Roentgenol* 31, 366-377, March, 1934.
- <sup>2</sup> Lane-Clayton, Janet E. Reports on Public Health and Medical Subjects, No. 59. Ministry of Health, London, 1930.

- <sup>3</sup> Frank, L W , Enfield, C D , and Miller, A J    Carcinoma of the Tongue in a New Born Child    *Am J Cancer*, 26, 775-777, April, 1936
- <sup>4</sup> Belote, C H    The Association of Carcinoma of the Tongue and Syphilis    *J A M A*, 94, 1985-1986, June, 1930
- <sup>5</sup> Fraser, John    Carcinoma of the Mouth and Tongue    *ANNALS OF SURGERY*, 96, 488-514, October, 1932
- <sup>6</sup> Fournier, J A    Sur la curabilit  du cancer en general et du cancer de la langue en particulier    *Bull de l'ac de med*, Paris, 56, 464-478, November 27, 1906
- <sup>7</sup> Lund, C C    Syphilis in Relation to Cancer of the Buccal Mucosa    *New England J Med*, 209, 131-134, July 20, 1933
- <sup>8</sup> MacGregor, J A    Malignancy of the Tongue on a Luetic Base    *N Y State J Med*, 30, 907-909, July, 1930
- <sup>9</sup> Meland, O N    Intra-Oral Cancer and Its Treatment    *Radiology*, 24, 276-280, March, 1935
- <sup>10</sup> Raven, R W    A Study of Cancer of the Buccal Cavity with the End Results of Treatment    *St Barth Hosp Rep*, 66, 65-124, 1933
- <sup>11</sup> Simmons, C C    Treatment of Oral Cancer    *Am J Roentgenol*, 26, 5-11, July, 1931
- <sup>12</sup> Pfahler, G E, and Vastine, J H    Irradiation Therapy in Cancer of the Mouth, Technic and Results    *Radiology*, 22, 15-26, January, 1934
- <sup>13</sup> Berven, E G E    Development of Technic and Results of Treatment of Tumors of the Oral and Nasal Cavities    *Am J Roentgenol*, 28, 332-343, September, 1932
- <sup>14</sup> Judd, E S, and Phillips, J R    The Curability of Carcinoma of the Tongue    *Proc Staff Meet*, Mayo Clin, 9, 9-11, January, 1934
- <sup>15</sup> Blair, V P, Brown, J B, and Womack, N A    Cancer in and about the Mouth    *Internat J Orthodontia*, 16, 188-209, February, 1930
- <sup>16</sup> Phillips, R    Histology of Buccal Carcinoma in Relation to Prognosis and Radio-sensitivity    *Lancet*, 1, 118-122, January 17, 1931
- <sup>17</sup> Simmons, C C    The Treatment of Oral Cancer    *Am J Roentgenol*, 26, 5-11, July, 1931
- <sup>18</sup> Lund, C C, and Holton, H M    Carcinoma of the Buccal Mucosa    *New England J Med*, 208, 775-780, April 13, 1933
- <sup>19</sup> Semken, G H    Nelson New Loose-Leaf Surgery, 2, 867-880, 1932
- <sup>20</sup> Blair, V P, and Brown, J B    Treatment of Cancerous or Potentially Cancerous Cervical Lymph Nodes    *ANNALS OF SURGERY*, 98, 650-661, October, 1933
- <sup>21</sup> Fischel, E    Surgical Treatment of Metastases to Cervical Lymph Nodes    *Am J Roentgenol*, 29, 237-240, February, 1933
- <sup>22</sup> Butlin, H J    The Results of Operations for Carcinoma of the Tongue, with an Analysis of 197 Cases    *Brit M J*, 1, 1-6, January 2, 1909
- <sup>23</sup> Hartmann, P    Traitement du cancer de la langue    *Paris m d*, 79-80 326-332, April 4, 1931
- <sup>24</sup> Fischel, E    The Treatment of Carcinoma of the Tongue    *J Missouri M A*, 27, 541-546, November, 1930
- <sup>25</sup> Moure, P, and Martin, R H    Resultats eloignes du traitement chirurgical du cancer de la langue    *Bull Soc fran  de dermat et syph*, 39, 412-416, March 10, 1932
- <sup>26</sup> Brown, J B    Cancer about the Mouth    *South Surg*, 3, 47-50, March, 1934
- <sup>27</sup> Gask, E E    A Contribution to the study of the Treatment of Epithelioma of the Tongue    *Lancet*, 1, 223-227, February, 1930
- <sup>28</sup> New, G B, and Figi, F A    Malignant Diseases of the Mouth, Pharynx, and Larynx    *Surg, Gynec & Obstet*, 60, 483-484, March, 1935
- <sup>29</sup> Patterson, N    The Use of the Diathermy Knife in Malignant Diseases of the Mouth, Nose, and Pharynx    *Lancet*, 2, 633-636, 694-698, September, 1934
- <sup>30</sup> Cade, S    Radium Treatment of Cancer of the Tongue    *Lancet*, 2, 630-632, September 20, 1930

- <sup>31</sup> Quick, Douglas Radium and Surgery in Cancer of the Tongue Brit M J, 2, 944-947, December 6, 1930
- <sup>32</sup> Regaud, C Les épithéliomas de la cavité buccale, leur traitement par le radium et les rayons X J de med et chir prat, 103, 15-28, January 10, 1932
- <sup>33</sup> Berven, Elie Resultats du traitement radiotherapique des cancers de la buccale cavite et du pharynx Gaz med de France (supp Radiologique), 377-378 May 15, 1935
- <sup>34</sup> Roux-Berger, J L Cancer de la langue (Statistique de la Foundation Curie) Bull et mem Soc Nat de chir, 58, 1343-1345, November 19, 1932
- <sup>35</sup> Delrez, L, and Desai, P Statistique des épithéliomas de la cavite buccale anterieure (langue plancher de la bouche, voûte palatine et face interne des joues) Liege med, 27, 721-736, June 3, 1934
- <sup>36</sup> Pfahler, G E Treatment of Cancer of the Mouth by Surface and Interstitial Radiation Radiology, 23, 472-475, October, 1934
- <sup>37</sup> Fitzwilliams, D C L Modern Treatment of Carcinoma of the Tongue West London Med J, 35, 195-210, September, 1930

# THE CARE AND CURE OF CANCER PATIENTS

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It is difficult to understand why the term palliation, or palliative treatment, has been applied in a rather derogatory sense to the care of cancer patients for whom a lasting cure is thought impossible. Few clinicians would be so bold as to talk about the cure of patients with valvular heart disease, arteriosclerosis, diabetes, or nephritis, even though by energetic and thoughtful medicinal therapy and by careful regulation of patients' lives many useful and happy years may be given to these unfortunate individuals. So far as I know, the expression "palliative treatment of cardiac disease" or "palliative treatment of diabetes" does not exist, and rightfully so, when in fact, the chance of a cure in these conditions is less than in many types of cancer. All individuals eventually die, and the result of the treatment of any disease can only mean postponement of this event. In spite of this, elimination of death—or something that is inevitable—is the sole criterion by which the care of cancer patients is often judged. What of the ones for whom life has been made more comfortable, mentally and physically, over a period of months or years by judicious surgery or radiation? Can their therapy not also be called successful even though they do not survive to be classed as three, five, or ten year "cures"?

In the fall of 1931 a young girl, with a melanoma in the skin above the right breast and a large mass of metastatic melanoma in the axillary lymph nodes, was referred to me for operation. The axillary tumor was growing rapidly and was causing pain and discomfort because of its size and position. The patient knew what she had and was desperate in her determination for operation. A painstaking and thorough dissection of the right axilla and wide excision of the primary tumor was performed even though at the time early recurrence seemed inevitable. It is not the fact that this patient was well and without signs of recurrent tumor three years later which I wish to record, but rather the fact, that had she survived only one or two years after operation, the mental and physical relief experienced by this girl was sufficient to classify this with the most satisfactory surgically treated cases of cancer. Had the patient died at the end of two years her case would never have been listed in the group of three or five year "cures" of melanomata, even though in many ways considering the size and extent of the axillary metastases, her treatment was just as successful.

Recently one of my patients died of pulmonary metastases from cancer of the breast ten years after the original mastectomy performed by Dr William A Downes. The scar resulting from the operation remained well



healed until the rather injudicious use of radium in another clinic, for an obviously incurable metastasis in the sternum. This caused necrosis of the bone and overlying skin which must be considered rather the result of the treatment than of the disease. In spite of this, and in spite of the fact that the patient eventually died of her cancer, can anyone deny that the original treatment of her breast cancer was satisfactory?

The biology of the patient and of the individual tumor are two absolutely unknown and all important factors which are present in every case of malignant disease. It is true that certain structural and growth characteristics may give some indication as to the biology of a given class of tumors, although it must be remembered that little can be said with assurance about any one case. This is, of course, true of many diseases, especially the infectious ones, where individual immunity and resistance play such all important rôles. Prognosis in every instance must be guarded, as frequently the most desperately ill patients will recover. The point which I would like to emphasize is that in treating cancer patients we are treating, in each individual case, absolutely unknown qualities and quantities, and the best results can be obtained only by the unrelenting surgical, radiologic, and medicinal care of all patients.

Specific agents for the cure of human diseases are few in number and are applicable to a relatively small number of sick individuals. Various serums for some of the infectious diseases, quinine for malaria and salvarsan for syphilis, are about all. In some cases of primary anemia, liver seems almost specific, not in curing the disease but in relieving the symptoms, for when the liver is discontinued for any length of time the normal course of the disease is resumed. Death from diabetes has been postponed for many patients and in this prolonged period of time they may die of accident or other disease, but, in the main, such an agent as insulin has not decreased the death rate from the disease for which it is supposed to be specific. In other words, insulin in the treatment of diabetes does nothing more than surgery and radiation in cancer. The following comment by Joslin<sup>1</sup> is interesting in this connection: "Deaths from diabetes are said to be increasing, despite the discovery of insulin, but if you will analyze the statistics you will find that the mortality is increasing at the right end of life, namely, the older ages. Since insulin was discovered our Massachusetts statistics show that deaths from diabetes have diminished for all ages up to 50 years and the increase has been confined almost exclusively to individuals between 60 and 70 years of age or older. In other words, young diabetics are living, whereas the older diabetics have not acquired immortality." Therefore, in the light of the study of other diseases it would seem that an absolute and all inclusive specific agent for the cure or treatment of cancer patients is something which cannot be anticipated, but if such an agent should be discovered it will make a rather unique chapter in the history of the treatment of chronic diseases.

It seems reasonable to believe that the only true method of estimating

the value of all forms of treatment of cancer is the study of the end-results secured in the treatment of all patients applying for admission to any given clinic or institution. Instead of that, reports of the results of very selected groups of cases are continuously being published. Would it not be instructive and highly interesting for our larger clinics for malignant disease to furnish us with the results of all patients treated, whether by radiation, surgery, or both, and regardless of whether the cases were considered favorable or not? This would eliminate entirely the personal element of the physician in the choice of suitable cases and would also eliminate the tremendous error which is recognized by all to exist in the clinical or pathologic grading of tumors. In other words, the end-results obtained in the treatment of all patients with cancer are far more important than the results obtained in a few, selected, favorable ones.

In 1928, I studied and reported the operability of 1,000 unselected patients with cancer who applied for admission to St. Luke's Hospital from July 1, 1923, to January 1, 1927.<sup>2</sup> Sixty-two of these were declined in the admitting office as too hopelessly advanced for admission, 299 were cared for on the medical and surgical wards as too advanced for operation, seven refused operation, 255 had operations for the relief of symptoms only, 87 had purely exploratory operations, and complete eradication of the tumor was

TABLE I  
RESULTS SECURED IN THE TREATMENT OF 744 CONSECUTIVE CASES OF MALIGNANT DISEASE

Site	Total Cases	Operable Cases							Per	
		Oper- able Cases	Per Cent of Op- erabil- ity	Op- er- ative Deaths	Not Fol- lowed Over 2 Years	Fol- lowed	Known to Have Lived 3 Years	Known to Have Lived 5 Years	"Inop- erable Cases" Lived 5 Years	Cent 5 Year Cures of All Cases
Breast	142	72	50.7	1	15	56	39	26	6	22.5
Stomach	109	18	16.5	9	6	3	1	0	0	0.0
Colon	52	21	24.7	12	1	8	6	4	0	7.6
Rectum	49	14	28.5	4	3	7	5	5	0	10.2
Uterus, cervix	73	12	16.4	0	5	7	4	2	0	2.7
Uterus, corpus	21	8	38.0	2	2	4	4	3	0	14.2
Skin	16	11	68.7	0	4	7	6	3	0	28.7
Lips	12	11	91.6	0	2	9	6	4	0	33.3
Ovaries	27	5	18.5	0	2	3	1	1	0	37.0
Gallbladder	9	2	22.2	1	0	1	1	1	0	11.1
Kidney	10	1	10.0	0	0	1	1	1	0	10.0
Tongue	3	2	66.6	1	0	1	1	1	0	33.3
Tonsil	3	1	33.3	0	1	0	0	0	0	0.0
Penis	2	2	100.0	1	0	1	1	1	0	50.0
Vulva	4	1	25.0	0	1	0	0	0	0	0.0
Fascia, sarcoma	6	1	16.6	0	0	1	1	0	0	0.0
All others	206	0	00.0	0	0	0	0	0	0	0.0
Totals	744	182	24.4	31	42	110	77	52	6	7.8

possible in only 320, or 32 per cent of the 1,000 patients. It is the follow-up of this same group of patients which I wish to report now. Unfortunately, 255 of the entire group were private patients and must be eliminated from our study because of the lack of accurate follow-up statistics. One other patient has also been eliminated because her tumor has since been judged benign, which leaves a total of 744 to be discussed (Table I).

In this unselected group of 744 consecutive patients with cancer admitted to the medical and surgical wards of St. Luke's Hospital, only 182 growths, or 24.4 per cent, were operable. Exploratory laparotomies, certain operations for the relief of symptoms, as colostomy, gastro-enterostomy, and gastrostomy, and the taking of biopsies were done in many of the so called inoperable cases, but in only 24.4 per cent of the entire group was an extirpation of the growth performed in the hope of a cure. This is distinctly lower than the operability in the group of 255 private patients who have been eliminated from this series. In this latter group, 137, or 53 per cent of the growths were operable. Several factors enter into this enormous difference in the two classes of patients. In the first place, the majority of private patients are seen by their surgeon before coming to the hospital and it is reasonable to suppose that many of the hopeless cases are eliminated in this way and spared the cost of hospitalization. This is no way true of ward patients, many of whom are admitted through the general admitting office for the sole purpose of consultation and hospitalization. There can be no doubt, however, that the majority of private patients do present themselves earlier for diagnosis and treatment, and in this way earlier and more operable cases are seen. If this is an important factor, one would expect an increase in the next few years in the inoperable cancer cases seen in private practice, the result of delay in consulting a physician due to the economic depression. It can only be suggested in conclusion that patients able to pay for private care in our larger city hospitals may also have been able and willing to pay for better and more expert medical advice, the result being earlier detection of cancer. In general, it must be said that an operability of only 24.4 per cent of such a series of ward patients is a deplorable condition and explains in the beginning the small percentage of five-year survivals obtained. Education, first of the medical profession, and second of the laity, is the only means of correcting such a condition.

Of the 182 patients operated upon with the idea of a cure, 31 died as the immediate result of the operation, an operative mortality of 16.9 per cent. This leaves only 151, or 20.2 per cent of the original 744 patients who were discharged from the hospital with any assurance of the possibility of outliving their disease for a period of years.

Follow-up of ward patients in such a city as New York with its ever changing and moving population is extremely unsatisfactory. Language difficulties, and the frequently suspicious attitude toward all investigators, make the tracing of patients who refuse or neglect to attend the regular follow-up

clinics well nigh impossible. In this series we have been able to follow and repeatedly examine 110 of these 151 supposedly cured patients. Seventy-seven are known to have lived three years and 52 five years. To these must be added six patients with advanced and "inoperable" breast carcinomata who survived five years after what were considered at the time to be purely palliative mastectomies. This makes a total of 58 known five year survivals or 37 per cent of all the patients surviving radical operations, and 78 per cent of the entire group of 744 (Table I).

The actual number of five year survivals is obviously greater than the known 58. It is reasonable to suppose that approximately 37 per cent of the untraced 42 patients surviving radical operations lived five or more years, and it is possible and very probable that some of the patients with inoperable but radiosensitive tumors were treated by radiation elsewhere after their discharge from St. Luke's Hospital and remained well for five years. This is certainly true of some of the patients with advanced carcinomata of the cervix uteri who were referred directly to other well equipped clinics for radiotherapy. All of these patients upon whom no operation was performed have been lost to our follow-up clinic. Correcting our figures, then, to allow for the same percentage of cures in the 42 untraced patients as in the followed group, and to include a few conjectured but absolutely unknown cures from radiation in some of the inoperable cases, it would seem that ten per cent five year survivals of the 744 original cases would be nearer the real truth. This is indeed a small number and illustrates my original thesis that our problem at the present time is by necessity more the care than the cure of cancer patients.

For purpose of discussion I have divided the 58 five year survivals into the following six main groups: (1) five miscellaneous, totally unrelated cases, (2) seven carcinomata of the skin and lips, (3) five of the uterus and cervix, (4) nine of the gastro-intestinal tract, (5) 26 operable carcinomata of the breast, and (6) six inoperable carcinomata of the breast. In all of these the diagnosis has been made by histologic study of the specimens.

Several of the cases in the first group are self-explanatory and need no discussion. One patient with a carcinoma of the tongue, in whom local excision of the growth only was performed, is living and well eight years later. Another patient in whom an early carcinoma of the gallbladder was found unexpectedly on histologic examination of the specimen is well after eight years. Perhaps one of the most interesting cases of the entire series is that of a man, age 60, with a hypernephroma of the left kidney. The kidney removed by Dr. Frank Mathews measured 21x13x8 cm. and was almost entirely replaced by tumor. At the time of operation the prognosis for this patient was thought to be extremely bad, yet he has remained well for seven years. This case illustrates well the value of unremitting treatment of all cancer patients because of the impossibility of correct prognostication in every case (Table II).

# CARE AND CURE OF CANCER

TABLE II

GROUP I FIVE YEAR SURVIVALS—MISCELLANEOUS CASES

	Age	Location of Lesion	Results
(1) E S	48	Epithelioma of tongue	Local excision Well 8 yrs
(2) H S	62	Carcinoma of gallbladder	Cholecystectomy (No gross tumor Sections show early carcinoma ) Well 8 yrs
(3) W McS	63	Hypernephroma of kidney	Left nephrectomy (Kidney measured 21 x 13 x 8 cm and was almost en- tirely replaced by tumor ) Well 7 yrs
(4) H M	29	Papillary adenocarcinoma of ovaries	Bilateral salpingo-oophorectomy Liv- ing with recurrences 8 yrs
(5) J McG	54	Epithelioma of penis	Circumcision and bilateral dissection of groins Died after 9 yrs with local recurrence and cerebral metastases

TABLE III

GROUP 2 FIVE YEAR SURVIVALS—LIP AND SKIN CASES

	Age	Location of Lesion	Results
(6) M F	41	Adenocarcinoma of labial nodes of upper lip	Local excision Well 5 yrs
(7) A E	51	Epithelioma of lower lip	Local excision Dissection left side of neck Living with recurrences in neck 5 yrs
(8) T B	69	Epithelioma of lower lip	Local excision Dissection on right side of neck Well 7 yrs
(9) R M	66	Epithelioma of lower lip	Removal of lip Plastic repair Died of distant metastases after 5 yrs
(10) T H	61	Basal cell epithelioma of cheek	Local excision Died with local re- currences after 6 yrs
(11) E C	43	Basal cell epithelioma of forehead	Local excision Well 7 yrs after ex- cision of recurrences
(12) J S	70	Basal cell epithelioma of preauricular region	Local excision with plastic repair Well 9 yrs

TABLE IV

GROUP 3 FIVE YEAR SURVIVALS—UTERUS AND CERVIX CASES

	Age	Location of Lesion	Results
(13) L K	53	Adenocarcinoma body of uterus	Panhysterectomy and bilateral sal- pingo-oophorectomy Well 8 yrs
(14) M F	66	Adenocarcinoma body of uterus	Panhysterectomy and bilateral sal- pingo-oophorectomy Well 7 yrs
(15) M S	45	Sarcoma of uterus	Supravaginal hysterectomy and bilat- eral salpingo-oophorectomy Well 9 yrs
(16) M R	37	Epithelioma of cervix	Excision of cervical stump (Supra- vaginal hysterectomy 1 yr previ- ously ) Well 8 yrs
(17) S W	34	Adenocarcinoma of cervix	Panhysterectomy and bilateral oophor- ectomy Died with recurrences after 6 yrs

The second group of seven carcinomata of the lips and skin (Table III) and the third of five carcinomata of the uterus and cervix (Table IV) are self-explanatory and require no further comment. The fourth group of nine gastro-intestinal cases is interesting mainly because of the localization of the growths. It is immediately seen that there are no five year survivals of 109 total cases and 18 operable ones of carcinoma of the stomach. One of these patients lived with recurrences for three years after operation. It is interesting to note that no patient in this series of colon and rectal cancers who has lived for five years after radical excision of the growth has subsequently died of recurrences. The one patient who survived seven years after resection of the cecum for carcinoma has recently died of pneumonia and at autopsy careful search of all the thoracic and abdominal organs failed to reveal gross or microscopic cancer. So far as one can say, this patient was truly "cured" of his cancer (Table V).

TABLE V

## GROUP 4 FIVE YEAR SURVIVALS—GASTRO-INTESTINAL CASES

	Age	Location of Lesion	Results
(18) T V Z	67	Gelatinous carcinoma of rectum	Resection Well 8 yrs
(19) C C	36	Adenocarcinoma of rectum	Resection Well 8 yrs
(20) S McD	49	Adenocarcinoma of rectum	Resection Well 7 yrs
(21) K W	37	Adenocarcinoma of rectum	Resection Well 7 yrs
(22) F J	51	Adenocarcinoma of rectum	Resection Well 5 yrs
(23) G P	50	Adenocarcinoma of splenic flexure	Resection Well 10 yrs
(24) C V	59	Adenocarcinoma of sigmoid	Resection Well 7 yrs
(25) H R	74	Adenocarcinoma of sigmoid	Resection Died of pneumonia after 7 yrs
(26) J W	54	Adenocarcinoma of cecum	Resection Died of pneumonia after 7 yrs No evidence of cancer found at autopsy

Few conclusions can be drawn from a study of the 26 operable breast carcinomata. The patients range in age from 26 to 75, the average being 48 years. The axillary lymph nodes were involved in ten, or 38 per cent of these cases, and no record of axillary lymph node examination was made in one (Table VI). However, the group of six so called "inoperable" patients with breast cancers who lived for five years, following what was thought at the time to be a palliative mastectomy, is extremely interesting and instructive. In all of the cases, large, advanced and often ulcerated growths were present and mastectomy was performed to rid the patient of a malodorous and painful breast. Notes to the effect that the cases were surgically "inoperable" so far as eradication of the disease was concerned appear on the operative records of five of the patients, while in one the growth was considered inoperable by me when I studied the history because the axillary fat and fascia were extensively involved with tumor. The axillary lymph nodes were involved in all. In no case was even the possibility of a

# CARE AND CURE OF CANCER

TABLE VI

GROUP 5 FIVE YEAR SURVIVALS—OPERABLE BREAST CASES

			Axillary Nodes Involved	Results
	Age	Type		
(27)	G C	36	Scirrhus	Yes Well 9 yrs
(28)	J B	67	Scirrhus	Yes Well 8 yrs
(29)	S M	45	Scirrhus	Yes Well 8 yrs
(30)	S B	61	Mixed	Yes Well 8 yrs
(31)	C C	63	Medullary	No Well 8 yrs
(32)	M H	42	Medullary	No Well 9 yrs
(33)	E B	39	Medullary	Yes Well 7 yrs
(34)	M A	49	Medullary	Yes Well 7 yrs
(35)	M B	49	Medullary	No Well 8 yrs
(36)	E A	47	Medullary	No Well 7 yrs
(37)	M H	58	Medullary	No Well 10 yrs
(38)	P W	56	Papillary	No Well 9 yrs
(39)	T N	56	Adenocarcinoma	No Well 8 yrs
(40)	M W	26	Adenocarcinoma	No Well 9 yrs
(41)	L G	40	"Carcinoma"	No Well 6 yrs
(42)	E B	68	Gelatinous	No Well 10 yrs
(43)	E S	62	Adenocarcinoma	No Well 9 yrs
(44)	M M	47	"Carcinoma"	No Well 9 yrs
(45)	J S	39	"Carcinoma"	Yes Living with recurrences 9 yrs
(46)	H B	48	Scirrhus	Yes Living with metastases 7 yrs
(47)	H H	42	Duct carcinoma	Yes Opposite breast removed for carcinoma 4 yrs later Living with recurrences 6 yrs
(48)	F F	48	Scirrhus	? Died after 7 yrs
(49)	E C	52	Medullary	No Died after 7 yrs
(50)	C R	44	Scirrhus	Yes Died after 6 yrs
(51)	C A	43	Scirrhus	No Died after 6 yrs
(52)	H C	75	Carcinomatous cyst	No Died after 6 yrs

five year survival entertained Postoperative radiation was given in four cases Three of this group of six patients are living without recurrences after eight years, one died of her disease after six years, another after seven years, and one died of heart disease seven years after operation (Table VII) These six five year survivals of such seemingly hopeless cases should make any surgeon hesitate before refusing radical surgery to patients with advanced breast cancer

Finally, mention must be made of a small group of patients with subsequently proved benign lesions upon whom radical operations were performed for supposedly malignant disease In two instances radical surgery was indicated because of the extent of the local lesions but in one case it was unnecessary These operations were not exploratory in character but were performed with mental assurance on the part of the surgeon that he was dealing with a malignant neoplasm These mistakes were in one instance dependent on misinterpretation of a biopsy specimen and roentgenograms, but in the other two cases they were due to lack of use of all available means

TABLE VII

## GROUP 6 FIVE YEAR SURVIVALS—"INOPERABLE" BREAST CASES

		Age	Type	Axillary Nodes Involved	Results
(53)	M McM	60	Adenocarcinoma	Yes	"Inoperable," almost ulcerating mass in axillary tail Well 8 yrs
(54)	L S	48	Scirrhus	Yes	"Inoperable" large ulcerating growth Well 8 yrs
(55)	M McF	22	Medullary	Yes	"Inoperable" large growth Well 8 yrs
(56)	A G	42	Adenocarcinoma	Yes	"Inoperable" large ulcerating growth Died after 7 yrs
(57)	B O	55	Medullary	Yes	"Inoperable" mass size of orange Died of heart disease after 7 yrs
(58)	E H	39	Medullary	Yes	Axillary fat and fascia involved Died after 6 yrs

for correct diagnosis There can be little surgical excuse, either practically or theoretically, for proceeding with radical surgery for supposedly malignant disease without histologic diagnosis of a biopsy specimen These specimens must be taken by the surgeon with care and thought, so as to give the pathologist suitable material upon which to base his opinion He has no choice except to examine the material sent him and it is not his responsibility if some tumor tissue is not included in the specimen I cannot decide whether it is a compliment or an insult to a pathologist to present him with a few cells or a fragment of tissue removed from a growth, or its neighborhood, and expect him to make a diagnosis of the lesion actually present in the patient It seems very much like showing a clinician a fragment of a temperature chart and compelling him to guess at the remainder Biopsy specimens of adequate size and from representative portions of a growth are surely best obtained by gentle surgical means, and, so far as I know, no experimental or surgical evidence has yet been advanced to show that this method is detrimental to a patient with malignant disease

**SUMMARY**—In this discussion I have tried to emphasize the fact that cancer is only one of several chronic noninfectious diseases and that its treatment differs in no essential way from that of the others Prolongation of life with the maximum mental and physical comfort, rather than the elimination of death, is the supreme goal and can be obtained in the greatest number of cases only by the continued, painstaking, and thoughtful care of all patients No patient is ever too ill or his tumor too advanced, for some form of physical or psychic therapy, and no physician at the present time is in a position to forecast correctly the duration of life in all cases The biology of the tumor and the biology of the patient are two absolutely unknown qualities and quantities, present in all cancer cases

Fifty-eight five year survivals of 744 unselected, consecutive patients with cancer applying for admission to St Luke's Hospital from July 1, 1923, to



January 1, 1927, are reported. This is only 7.8 per cent of the total number, but 37 per cent of the patients surviving radical operations. A review of these cases cannot help but impress one with the fact that a definite prognosis must be given with extreme care in every case of cancer, and that not infrequently a patient with an advanced and seemingly hopeless tumor will outlive his disease for a period of years.

I wish to express my thanks to the members of the Surgical Staff of St. Luke's Hospital for permission to study and analyze their cases.

#### REFERENCES

- <sup>1</sup> Joslin, E. P. Diabetes. Its Control by the Individual and the State. Harvard University Press, 1931.
- <sup>2</sup> Shore, B. R. Operability in Cancer. Statistical Study of 1,000 Cases. J. A. M. A., 90, 1690-1692, 1928.

# SUBASTRAGALAR ARTHRODESIS IN PARALYTIC DEFORMITIES

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IN THE *Archives of Surgery* for February, 1929, the writer described a method of subastragalar arthrodesis for stabilizing the paralytic foot, and presented a preliminary report on seven cases. The operation, as that paper brought out, has the great advantage of providing for backward displacement of the foot, thereby establishing the better leverage for weight bearing that is often necessary to the paralytic foot. Now, after 11 years' experience with the method, it has been proved to the writer's satisfaction that in certain types of paralytic feet, this stabilizing procedure affords uniformly excellent results.

The purpose of this second report is to call attention again to this operative method, placing special emphasis upon the selection of the case and presenting a study of a series of 21 cases, included in which is the subsequent course of four of the cases previously reported.

*Indications for the Operation*—The indications for this operation are definitely defined. It is applicable to paralytic feet in which the anterior muscle group has sufficient control to prevent drop foot, and in which either the posterior muscle group, or the peroneal muscle group that may be substituted for the gastrocnemius is sufficiently strong to prevent calcaneus deformity. The posterior muscle group, to be efficient, need not have its full strength, for less leverage is required when the foot has been displaced backward at operation. When the peroneal muscle group is transplanted to allow its action to replace that of the paralyzed posterior muscle group, the substituted power makes it possible to plantar-flex the foot even to the extent of rising on the toes.

This method of arthrodesis is most successfully carried out in paralytic feet in cavus, valgus, or varus deformity associated with calcaneus. Strong peronei must, of course, be present to replace the heel cord. In the cavus foot the malposition is corrected at the time of stabilization by removing a plantar wedge from the calcaneocuboid region. Valgus or varus deformity is corrected by the removal of a section of bone from the subastragalar region, which varies in thickness on its inner or outer side depending upon the deformity to be corrected.

Another indication for this method is found in the extensively paralyzed foot that calls for stabilization.

Paralytic foot deformities in both the child and adult may be treated by this method. Primarily of course, it is used in younger patients, the ages between 10 and 16 being the best period. Never should arthrodesis be attempted

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before eight or ten years, since the formation of a bony ankylosis cannot be insured at an earlier age

*Operative Technic*—Before the arthrodesis is carried out, deformities should be corrected as much as possible by manipulative or minor operative measures

The incision is made on the outside of the foot, beginning over the dorsal surface in the midtarsal region, curving below the external malleolus, and terminating over the Achilles tendon. Care is taken to cut below the astragalocalcaneal joint in order to avoid severing the external lateral ligaments

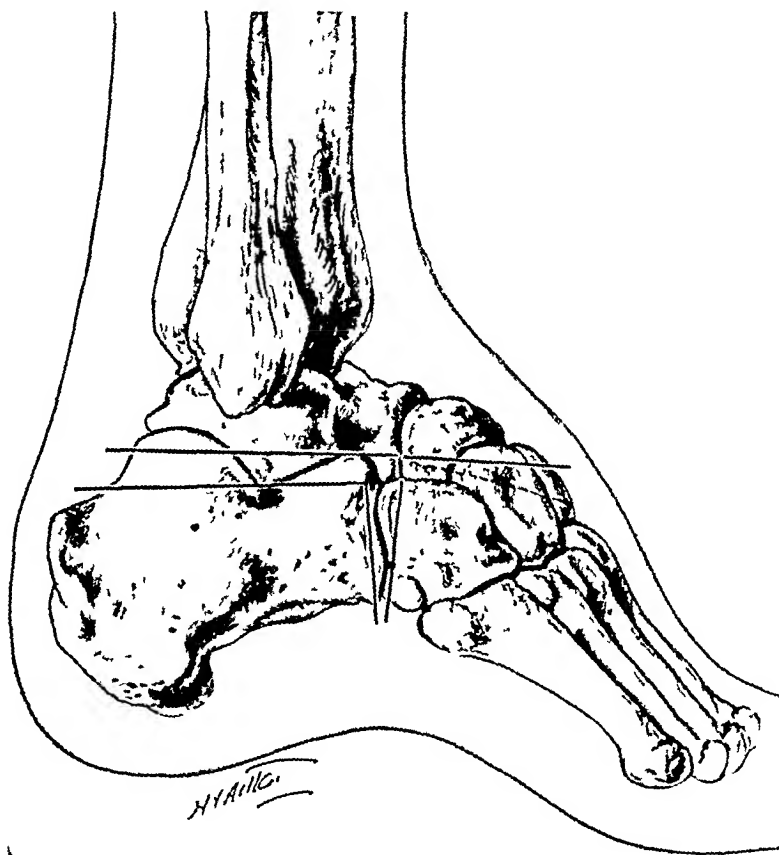


FIG. 1.—Diagrammatic drawing showing sections of bone removed from the os calcis, astragalus, and midtarsal and calcaneocuboid regions in the stabilization and correction of a foot in *cavus* deformity. Note—The drawing is diagrammatic. The direction of the saw lines and the removal of the calcaneocuboid wedge will depend upon the deformity present. As little bone as possible should be removed.

between the astragalus and the fibula. The skin and fascia on each side are dissected back.

The dorsal extensor tendons are retracted to the dorsum of the foot. The peroneal tendons are severed near their attachment and retracted, long sutures are inserted in their ends. The ligaments between the astragalus and the os calcis are severed. The capsule over the astragaloscaphoid joint and over the astragalocalcaneal joint is opened. The sole of the foot is brought into marked inversion.

If *cavus* is present, a V shaped wedge with its apex directed toward the

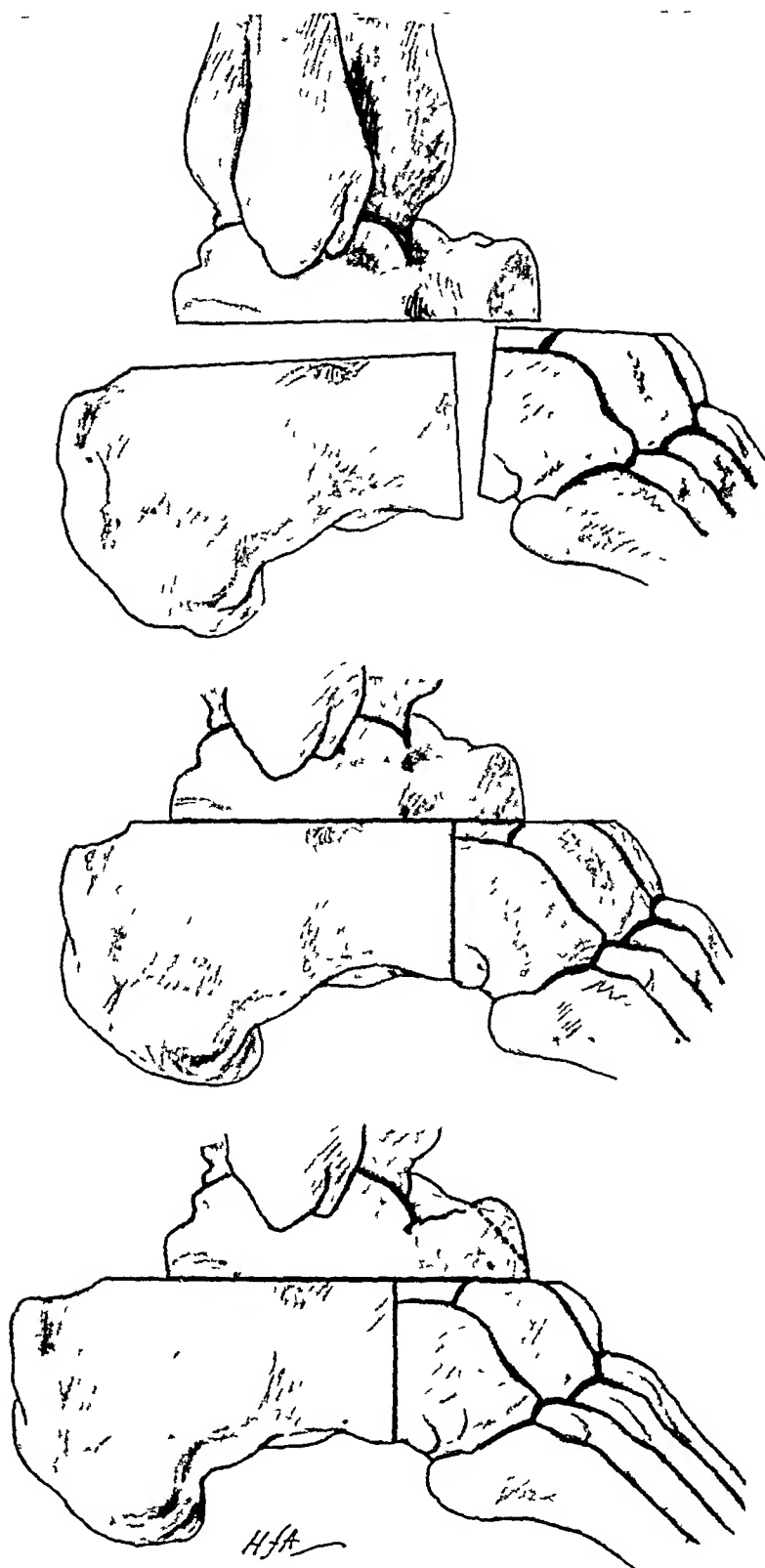


FIG. 2.—Diagrammatic drawings showing sections of bone removed and displacement of the foot backward. Note the dotted line indicating the removal of the protruding upper surface of the astragalus.

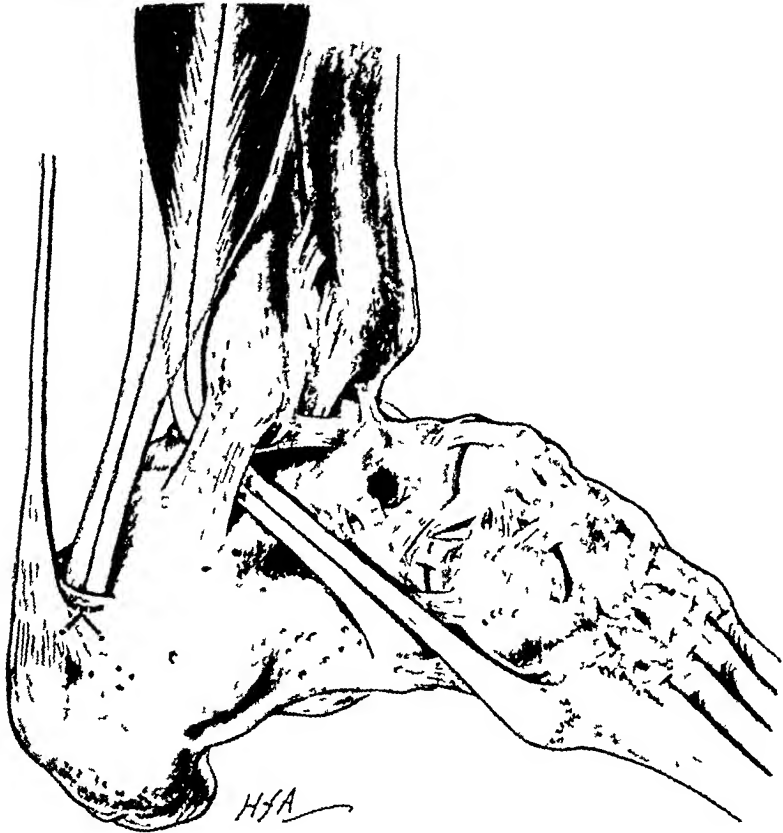


FIG 3—Transplantation of the peroneal tendons into the os calcis to replace the lost action of the Achilles tendon



FIG 4—(Case 1) C B An extremely weak foot with absent Achilles tendon Note the tibia riding posteriorly on the astragalus

plantar surface, and in size just sufficient to allow correction of the deformity, is removed from the calcaneocuboid region

The entire body of the astragalus is brought into the wound after the ligaments on the inner side of the talus have been dissected upward. Care must be taken in so doing not to disturb the ligamentous attachments of the tibia, fibula, and astragalus. A small section of bone, larger on the inner or outer side depending upon whether the foot is valgus or varus deformity, is removed from the lower surface of the astragalus. A similar transverse section is removed from the upper surface of the os calcis.

The os calcis is brought temporarily into relation with the astragalus and the cavus wedge is closed. A section of bone is then removed from the scaphoid and upper tarsus, the saw line being made continuous with the plane of the flattened surface of the os calcis.

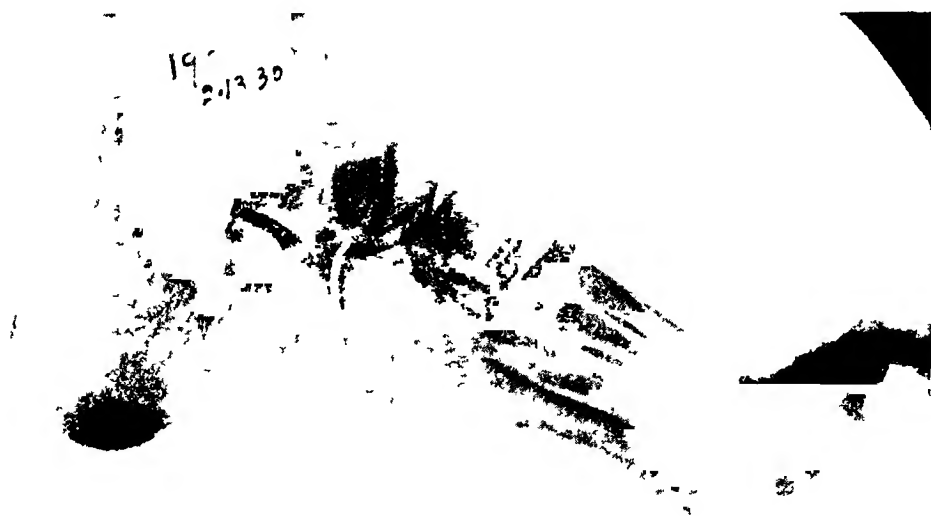


FIG 5—(Case 1) C. B. Preoperative roentgenogram showing calcaneocavus deformity and tibia riding posteriorly on the astragalus

The foot is displaced backward, and in so doing the remaining section of the scaphoid is brought in position to become arthrodesed to the overlapping neck of the astragalus. Any remaining prominence on the anterior superior part of the astragalus is shaved off (Figs 1 and 2).

Where no cavus deformity exists, the operation is carried out in the same manner as described, except that no wedge is removed from the calcaneocuboid region.

If transplantation of the peronei is necessary, the tendons are fixed into the os calcis at the site of the attachment of the Achilles tendon (Fig 3). The wound is closed in the usual manner.

A plaster of paris dressing extending from the toes to above the knee is applied, with the foot in five to eight degrees of plantar flexion. This position helps to maintain the posterior displacement of the foot. While the plaster casing is being applied the displacement backward is preserved by pressing



FIG 6—(Case 1) C B. Postoperative photographs taken six years after subastragalar arthrodesis. (A) Shows weight bearing with sufficient power in the transplanted peronei to support the full weight of the body in walking. (B) Shows the foot at rest.

with fingers on the sole of the foot and with the thumb on the bottom of the os calcis. The development of cavus is prevented by keeping the bottom of the plaster casing flat, while it is drying, with splint wood.

The foot is kept elevated, with the knee bent at the angle of 45 degrees, for ten days to three weeks. The plaster casing is then removed, the leg is brought into extension, and a new plaster bandage is applied from the toes to below the knee, with the foot at the right angle to the leg and in the position of slight valgus. Weight bearing is usually possible after six weeks. After ten weeks the plaster bandages may be discarded.



FIG 7—(Case 1) C B Postoperative roentgenogram taken six years after subastragalar arthrodesis, showing the foot in corrected position, solid arthrodesis, and backward displacement of the foot.

The foot is then protected by a shoe equipped with an outer upright and a stop joint which holds the corrected position and limits motion. Physiotherapy, gradual use, and exercise are begun.

The total number of arthrodeses of this nature that have been performed at our clinic is 21. End-results are available on 16 of these cases.

In this group of 16 cases there were 11 children who, at the time of operation, were between the ages of ten and 18 years. In one case of a child ten years of age, the operation was carried out on both feet for the correction of valgus deformity. The other four patients were in their early twenties.

In five cases calcaneocavus deformity predominated, in six cases the foot was in calcaneovalgus, in three cases, including the bilateral case, the foot was in valgus, and two patients had generally weak, unstable feet.



Final examination of the 16 cases was made after a period varying from eight months to 11½ years from the time of operation. In five cases more than 11 years had elapsed, in seven cases over five years had elapsed, in one case four years had passed, in two cases, one and two years respectively, and in one case, eight months.

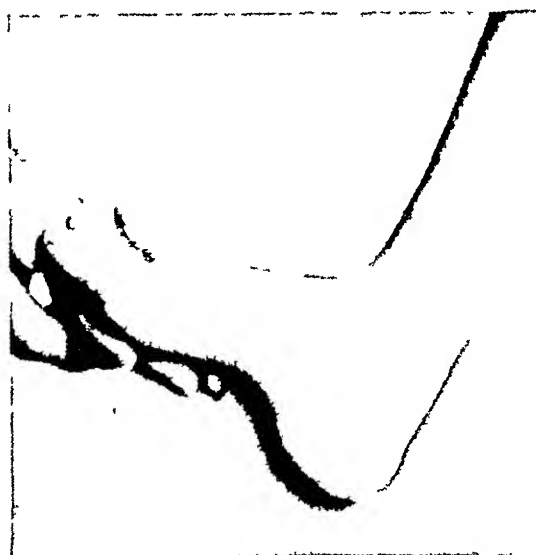


FIG 8—(Case 2) T L Calcaneocubus deformity before operation

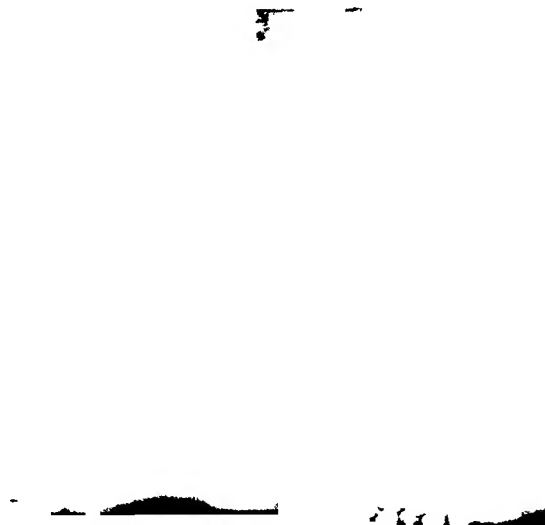


FIG 9—(Case 2) T L Postoperative view taken 11 years after subastragalar arthrodesis, showing foot in corrected position. Patient has an excellent weight bearing foot and walks well without a limp.



FIG 10—(Case 3) S P Calcaneocubus deformity before operation

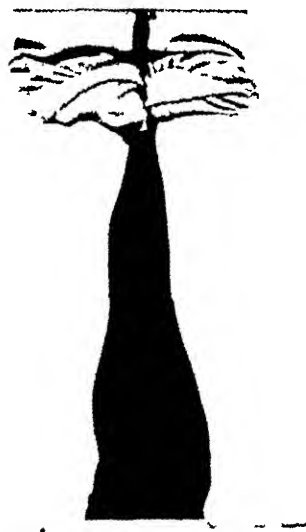


FIG 11—(Case 3) S P Postoperative view taken six months after subastragalar arthrodesis showing foot in corrected position. The patient has a stable, functional foot.

In the classification of the end-results, the term "good" is used to signify a case that has good stability, that has no symptoms and no limp, and the patient is able to walk without a brace. A study of the results based upon this criterion showed that all but one patient secured a stable, functional foot.

Figs 4 to 11) In the exceptional case the patient walks with the foot in varus deformity and is handicapped by the contraction of the great toe. This was one of the early cases of arthrodesis, and the failure to obtain an excellent outcome was due undoubtedly to imperfect operative technic.

#### CONCLUSIONS

By the use of the stabilizing method for paralytic feet herewith presented, both a functional stable foot and the correction of deformity are insured.

Mechanically, the operation has the advantage of providing for backward displacement of the foot, a measure that is often necessary in paralytic feet in order to shift the line of weight bearing nearer the center of the foot. The procedure in no way interferes with the integrity of the ankle joint, nor is it followed by sensitiveness or arthritic changes.

The indications for the use of this operation are definitely defined. It is limited to cases in which the anterior muscle group has sufficient power to prevent drop foot, and in which the posterior muscle group, or the peroneal group that may be substituted, is strong enough to prevent calcaneus deformity. The operation may also be considered purely for stabilization of generally weak feet.

Twenty-one cases have been stabilized by this method. The end-results in 16 of these cases, which it has been possible to trace, have been uniformly favorable.

# BRIEF COMMUNICATIONS AND CASE REPORTS

## RETROGRADE JEJUNOGASTRIC INTUSSUSCEPTION THROUGH A GASTRO-ENTEROSTOMY STOMA\*

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JEJUNAL intussusception through a gastro-enterostomy stoma is one of the late sequelae of the common operation for the relief of peptic ulcer, only 36 such instances having been reported in medical literature to date, including five in American publications<sup>1, 2, 3</sup>. Only four of the 36 were correctly diagnosed before operation, and in two of these the diagnosis was suggested to the physician by the patient, because of previous similar attacks with surgical intervention and cure. Of 37 cases (including ours), 28 were treated surgically, with 19 recoveries. Diagnosis in the nine unoperated patients was established at necropsy.

Bettman and Baldwin,<sup>1</sup> in 1933, were able to find 33 cases in an exhaustive review of the literature, two additional cases have been described by Adams,<sup>2</sup> and one by Chesterman.<sup>3</sup> Bettman and Baldwin, in their resumé, noted the following facts:

(a) The accident occurred as early as one year and as late as 16 years after the performance of the gastro-enterostomy.

(b) The size of the stoma bore no apparent relation to the incidence of the intussusception.

(c) The length of jejunal segment telescoped into the stomach varied from 5 to 200 cm, the average being 52 cm.

(d) The efferent loop was always involved, the afferent loop seldom.

(e) In only one case was the stomach examined fluoroscopically after ingestion of an opaque meal, in this instance the correct diagnosis was not made.

**Case Report**—W. H., white male, age 57, had had a gastro-enterostomy performed in 1920 for the relief of "ulcers," with complete symptomatic relief. He had no further complaints referable to the gastro-intestinal tract until September 5, 1935, when he was suddenly seized with epigastric colic of rapidly increasing severity, soon associated with retching emesis. The latter was clear at first, becoming blood tinged after about 18 hours; no clots or frank blood was noted.

On admission to the hospital, the patient was moribund and extremely dehydrated, with almost constant retching and hematemesis. Temperature 102° F., pulse 136, respiration 30. There was pronounced abdominal rigidity. No tumor masses were palpable. The blood count showed erythrocytes 6,080,000, leukocytes 18,000, with 83 per cent polymorphonuclears. The clinical picture suggested a perforated ulcer with peritonitis; the hematemesis being ascribed to trauma at the ulcer site from the pernicious vomiting. Sup-

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portive treatment failed to improve the patient's condition, and death ensued 30 hours after admission

Necropsy revealed an early bronchopneumonia and moderate arteriosclerosis. The stomach was somewhat fixed by adhesions about the pyloric segment, and contained a sausage shaped tumor, which proved to be a loop of jejunum telescoped into the stomach through a posterior gastro-enterostomy opening, and which had undergone partial digestion. The loop involved the first 65 cm of the efferent jejunal segment without implication of the afferent portion. The stoma measured 10.6 cm in circumference. There



FIG. 1.—Dorsal view of specimen at necropsy. The posterior stomach wall has been cut away, the pancreas has been retracted lateral and twisted upon itself to show the terminal duodenum entering the involved area. The directional arrows indicate the course of the intestine caudad from the pylorus. (1) Esophagus, (2) pylorus (3) tail of pancreas retracted lateral and upward, (4) third portion of duodenum, (5) site of stoma (6) telescoped loop of jejunum filling stomach, (7) efferent jejunal loop

was no evidence of active peptic ulcer, malignancy or peritonitis. A healed ulcer was found on the posterior wall of the duodenal cap. The vomited blood had come from eroded vessels of the digesting loop of intestine.

**COMMENT**—The above case is being reported, not only because of its interest as a pathologic curiosity, but also because the paucity of reported cases by American clinicians suggests the need of a greater familiarity with this condition on the part of both internist and surgeon. In Chesterman's case, a correct diagnosis of retrograde jejuno-gastric intussusception was made on the following criteria:

(1) The occurrence of acute epigastric colic in a gastro-enterostomized patient who had been symptom free from the date of his operation until the onset of the present illness.

## SACRAL CHORDOMA

(2) Repeated emesis of small amounts of blood intimately admixed with gastric secretions and with practically no clotted particles

(3) Epigastric tumor without rigidity, fever, or leukocytosis, and with only local tenderness

Chesterman stresses the diagnostic importance of this sequence of events, emphasizing the fact that colic is not a symptom of bleeding ulcer. In our case, the terminal condition of the patient on admission obscured the clinical picture, but the history was typically that outlined above.

### SUMMARY

A case of retrograde jejuno gastric intussusception is added to the series of 36 previously reported.

The syndrome of acute epigastric colic in an enterostomized patient, repeated hematemesis, and epigastric tumor without rigidity, is strongly suggestive of this condition.

Retrograde jejuno gastric intussusception should be included in that group of unusual conditions to which the diagnostician frequently finds it necessary to refer during the study of a difficult case.

### REFERENCES

<sup>1</sup> Bettman, R. B., and Baldwin, R. S. *J. A. M. A.*, 100, 1228-1229

<sup>2</sup> Adams, A. W. *Brit. M. J.*, 1, 248, February, 1935

<sup>3</sup> Chesterman, J. T. *Brit. J. Surg.*, 21, 541

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## SACRAL CHORDOMA\*

ONE YEAR AFTER RADICAL EXCISION

BRADLEY L. COLEY, M.D.

NEW YORK

**Case Report**—An American born female, age 63, first consulted me March 15, 1934, for pain and swelling in the right buttock. Her family history was irrelevant. Past History—She had had a perineal repair 36 years ago, appendectomy 13 years ago, and a hemorrhoidectomy three years ago. The present illness dated from a fall down a flight of stairs six years before, when she struck the lower end of her spine. Following this accident she states it was painful for her to sit down or put any weight on this region. Two years later she again slipped and fell down the same staircase, injuring the same region. Three months before she first consulted me she noticed a swelling in the right buttock and adjacent sacral region, and during the few months prior to her visit to me she had constant pain in this region. Roentgenograms revealed a destructive lesion of the lower end of the sacrum and proximal segment of the coccyx, which presented a moth eaten appearance with no evidence of repair or bone production. The appearance was suggestive of a neoplasm. An aspiration biopsy was performed. Pathologic report by Dr. Fred Stewart of the Memorial Hospital: "Aspiration yielded many small cells incorporated in a mucinous base. In the midst of the small cells are rather pale vacuolated cells, which are consistent with a diagnosis of chordoma."

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Because of the unfavorable results following surgery in most of the reported cases of Chordoma, the patient was referred to Dr Wm G Herrman, the radiologist, of Asbury Park, N J, with the suggestion that irradiation therapy be attempted. During the following year Doctor Herrman treated the patient with high voltage roentgen ray given as follows. In late March and early April, 1934, she received a series of fractional treatments, using two portals anterior and one posterior, the two anterior directed at the tumor, and the posterior given directly over it, giving a total of 1,594 r units to each portal. In July, 1934, a smaller series was given, a total of 855 r units anteriorly and 824 posteriorly, using two portals, the anterior being directly opposite the posterior. One year later Doctor Herrman again referred the patient to me because of the steady increase in the size of the tumor and constant pain, which was not relieved by irradiation therapy.

Examination March 12, 1935, showed that there had been a tremendous increase in the size of the tumor since the previous examination. There was now a large, firm swelling extending from a point close to the tuberosity of the ischium across to the outer aspect of the posterior part of the buttock. It was only slightly movable. Rectal examination did not reveal any encroachment into the pelvis. The bulk of the tumor and the fact that it made sitting down almost impossible, together with the failure of irradiation to hold it in check or to relieve symptoms, prompted me to advise an attempt at surgical removal, particularly since recent stereoscopic films still showed the area of bone destruction confined to the fourth and fifth sacral segments and the coccyx.

She was admitted to the Ruptured and Crippled Hospital March 19, 1935, where laboratory studies showed normal blood sugar and blood urea. The red blood cells were 4,300,000, hemoglobin 74 per cent, white blood cells 5,850, polymorphonuclears 64 per cent, lymphocytes 36 per cent. Urine was negative except for a very faint trace of albumin. Blood pressure 180/75. On March 21, 1935, under avertin anesthesia supplemented with nitrous oxide-oxygen, an incision was made extending from the left side of the sacrum across the midline to the right side and down the right gluteal region to the gluteal fold, a distance of some 25 cm. Through this incision the sacrum was exposed and divided through the fourth sacral segment with a chisel, the line of division being palpably proximal to the upper limit of involvement. The anterior surface of the sacrum was freed of areolar tissue overlying the rectum which was separated without damage. The dissection was then carried down along the gluteal region so that the entire tumor was eventually excised en masse and the wound closed. A small rubber dam drain was inserted which extended down to the dead space adjacent to the rectum which could not be completely obliterated when the skin over the sacral area was approximated.

*Pathologic Examination*—March 21, 1935. The old sections showed a tumor composed of large islands of a substance resembling a typical hyaline cartilage. These islands are walled off by trabeculae of dense fibrous tissue. The cartilage is atypical in that many of the component cells are vacuolated and resemble the "signet ring" cells with an eccentric peripheral flattened nucleus. In the more recent sections the same picture is seen. Vacuolization of two or more cells is noted in certain areas, giving a pseudoglandular appearance. The histologic picture seems identical with that of the sacrococcygeal chordoma as described by Stewart, Ewing and others. *Diagnosis*—Chordoma.

The wound healed satisfactorily without infection. The drains were shortened on the second postoperative day and removed on the fifth. Discharged on the twenty-second day.

The patient has returned for examination at frequent intervals and at no time has she complained of any of her previous symptoms. There was some irritability of the bladder, with urinary frequency, during her stay in the hospital, but this rapidly subsided. She has no difficulty in controlling her bladder and rectum. At each examina-

tion a slight bulging at the site of the removed lower sacral segment was noted when the patient coughed, but there has been no increase in the degree of this bulging, noticed either by the patient or by the examiner. She has been able to do her housework.

Roentgenograms taken following the operation showed a smooth stump of the sacrum at the site of the removal and no evidence of pathologic bone in the remainder of the sacrum or the base of the pelvis or lumbar spine. There are no complaints of sensory disturbances.

While remnants of the chorda dorsalis, a specific embryonal tissue about which the vertebral column develops, are regularly found in the intervertebral disks in infants, it has been shown that they commonly persist at the base of the skull and in the coccyx. Vuchow first described the small tumors originating from this tissue as "ecchordosis spheeno-occipitalis."

The sacrococcygeal chordoma varies considerably in its gross anatomy. Occasionally this tumor grows forward into the pelvis, where it causes interference with bladder and rectal function, and pain from erosion of bone and infiltration and pressure on nerves. When, as in the case reported, the tumors grow outward, very large masses may appear outside the sacrum. The growth is slow, Stewart placing the duration of sacral chordomata at six and one-half years. Of 15 cases which survived operation, 13 soon developed recurrence, and he found only two cases surviving operation three and five years respectively. Chordoma simulates closely two much more common tumors, *i. e.*, myxochondroma and colloid carcinoma of the intestinal canal. In a case of the latter type it may be extremely difficult to distinguish it from gelatinous carcinoma of the rectum. Local recurrence, however, is the rule and a fatal termination is usual.

Doctor Pool, in 1924, presented a case of sacrococcygeal chordoma before the New York Society. In his case a palliative operation was followed by roentgen therapy and use of radium emanation placed in the wound, with regression noted in the size of the tumor. The patient was shown two and one-half years after the operation. Dr. John F. Erdmann, in discussing this case, cited his experience based upon three cases.

Mabrey, in 1935, collected 150 cases. He credits Wood with first reporting in America, in 1913, a case of sacrococcygeal chordoma. He is unable to account for the delayed onset of these cases, for the greatest incidence occurs in the fifth and sixth decades, and states that it is twice as common in men as in women.

In the sacrococcygeal group, Mabrey's figures of 36 deaths with 16 autopsies and ten metastases, 62.5 per cent, would tend to refute the accepted belief that metastases seldom occur. He concludes that treatment in the sacrococcygeal cases is surgical, whenever possible. While surgical removal is so frequently unsuccessful, irradiation is also of little value as these tumors—as one would expect from their histologic nature—are radioresistant.

This case is shown to illustrate a manner in which total resection of the fourth and fifth sacral segments, together with removal of the bulky soft

part extension en masse, was apparently undertaken without unfavorable sequelae. At present the patient presents no evidence of recurrence.

DISCUSSION—DR JOHN H GARLOCK (New York) stated that Doctor Pool's case was alive and well three and one-half years ago, which was ten years after the palliative operation.

DR BYRON STOOKEY (New York) reiterated Doctor Coley's statement that chordoma occurs at either end of the vertebral column, in the sphenoid or in the sacral region. Differential diagnosis when the tumor is in the sphenoidal region is seldom possible until after operation, at which the conditions are found to be rather hopeless since it is not possible to remove the tumor and only palliative procedures can be employed. In the sacral region, disastrous results may certainly occur in attempting to remove the tumor, and if to remove it means destroying the innervation of the bladder and rectum, it is better for the patient, especially if it be a woman, to bear with the tumor. Doctor Stookey complimented Doctor Coley on his very skillful removal of the tumor and the excellent end-result, and, in conclusion, stated that Doctor Eckel of Buffalo had compiled a series of basosphenoidal as well as sacral chordomata, from the literature, which was most interesting.

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## TRAUMATIC ARTERIOVENOUS FISTULA OF THE PALM\*

WILLIAM DE W ANDRUS, M D

NEW YORK

Case Report—Mrs B LeD (No 112252), white, age 23, was admitted to the New York Hospital October 17, 1935, complaining of a painless swelling on the palmar aspect of the left hand. This swelling was noticed shortly after the emergency suture of a laceration produced by broken glass three and one-half years previously. The patient had been conscious throughout this period of a buzzing sensation in the region of the swelling. Aside from this peculiar sensation of vibration, the condition of the hand did not trouble her until about one year ago when she noted that the veins of her hand and lower left forearm were becoming swollen and more prominent. This was particularly marked after using the hands in daily household work. She had also noticed that the left hand was usually warmer and more moist than the right.

The patient presented herself for surgical treatment because of the noticeable enlargement, the subjective sensation of buzzing and vibration, and the fear that injury to the swelling might cause hemorrhage. Her past history was irrelevant.

*Physical Examination* was not remarkable other than for the findings relevant to the left upper extremity. Examination of the local lesion found a swelling in the region of the hypothenar eminence of the left hand, where a stellate scar was also visible. This swelling was easily compressible, and exhibited a thrill and bruit both synchronous with systole. The swelling covered an area approximating 5 x 3 cm in size and was raised 1 cm above the surface of the palm of the hand. About it there were numerous dilated veins, which extended halfway up the forearm. The ulnar artery could be compressed proximal to this swelling and its compression caused a diminution in the intensity of the bruit, but this was not entirely obliterated unless both the radial and the ulnar arteries were compressed simultaneously. Roentgenologic examination of the bones of the hand and forearm showed no appreciable variation from the normal, and

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## ARTERIOVENOUS FISTULA OF THE HAND

those of the soft tissues showed the arteries and the veins of the left forearm to be unusually large

The heart borders were within normal limits. A<sub>2</sub> was greater than P<sub>2</sub>. A soft systolic murmur was heard over the apex. The systolic blood pressure in the left arm, on repeated observations, was ten to 20 points higher than that in the right arm, though there was no significant change in pulse pressure. Blood pressure before operation 122/76 right arm, 132/80 left arm. Oscillometric readings on upper extremity were as follows: Right upper arm 10, right forearm 9, left upper arm 4, left forearm 3. Skin temperature over the left hand and the ulnar half of the left forearm was consistently four to five degrees higher than the same area on the right side. Special examinations with regard to the heart showed that the cardiac shadow on the roentgenogram was not



FIG 1—Drawing showing the dilated veins about the arteriovenous fistula

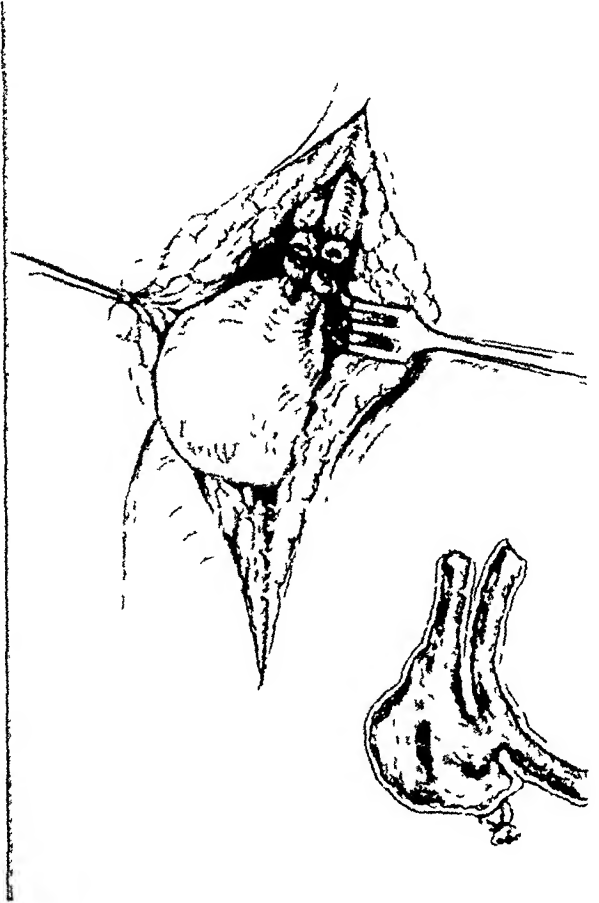


FIG 2—Drawing showing the exposure of the arteriovenous fistula, and the appearance on cross section of the specimen

unusual, and was not an evidence of cardiac enlargement. The electrocardiographic readings were reported as essentially normal. Erythrocyte, leukocyte, and hemoglobin counts were within normal. Urinalysis was normal and the serologic tests for syphilis were negative.

*Operation*—October 28, 1935. Under general anesthesia a tourniquet was applied to the left arm, and the palmar region explored through a curved linear incision 8 cm long. Dissection revealed that the lesion was an arteriovenous fistula, between the superficial volar arch and the corresponding vein, with dilatation of the regional veins. Quadruple ligation of the involved vessels was performed with excision of the fistula bearing segments. A somewhat striking point in the examination of the fistula at operation was that the artery distal to the fistula did not vary appreciably in size from that proximal. It was the operator's impression that this was due to the large collateral circulation between the superficial and deep palmar arches. After the excision, the ligated stump

of the ulnar artery could be seen to pulsate visibly and pulsation could be obtained in the radial artery

Immediately postoperative, the patient stated that she was no longer conscious of the buzzing and vibrating sensation in the left hand. A transient tourniquet palsy occurred which cleared up before discharge from the hospital 16 days postoperative. Electrocardiograms taken after operation showed no striking variation from those taken preoperatively.

*Pathologic Examination*—The specimen consisted of a small, rather thick walled vessel, 3.5 cm long and 0.5 cm in external diameter, threaded on a probe. At one end was a dilated aneurysmal mass resembling a varicose vein, measuring 2.7 cm in length and 1 cm in external diameter. On opening the sac it was found to be lined with smooth endothelium and to be composed of a large, dilated cavity with a beaded, tortuous, sac like extension several millimeters in diameter. The sac was quite empty and the point of communication with the larger vessel was extremely difficult to locate. It was finally found in the smaller sac like projection and measured slightly over 1 mm in diameter.

This patient illustrated very well the tremendous enlargement of the veins which may take place after the development of an abnormal arteriovenous communication, and the ease with which the condition may be rectified after elimination of the fistula. Fortunately the abnormal communication occurred between vessels around which there is very ample collateral circulation so that their ligation was attended by no untoward sequelae.

DR H. H. M. LYLE (New York) stressed the rarity of aneurysm of the hand in view of its rich circulation, the trauma to which it is frequently exposed, and the number of foreign bodies that have to be extracted from it. Since the presentation of a paper by him before the American Surgical Society, which was based on a study of 64 true aneurysms of the hand, the earliest of which dated back to 1837, two cases have been added by Doctor Matas, bringing the total to 66. In his search for cases with true aneurysm of the hand, he encountered a fair number of descriptions of a clinical variety of arteriovenous fistula that might be called a delayed type, that is, a congenital variety which seems to be activated by trauma, and which gives a very different prognosis and which is difficult to cure. Dr J. Douglas presented such a case before the New York Surgical Society some years ago and the speaker had had one such case in addition to one he saw recently in consultation with Dr W. MacFee. To emphasize the rôle of trauma, the following case was cited:

*Case Report*—A boy, age 21, ran a fragment of glass into his hand, in 1920. In 1926 he broke his ring finger playing handball, and entered New York Hospital for treatment. The fracture was set and after three weeks the splint was removed, but the hand did not do well. The boy suffered a great deal of pain in his palm and there was considerable stiffness of all fingers. The condition was treated by heat and other usual measures without improvement, until, 20 months later, he was admitted to St. Luke's Hospital where a diagnosis of aneurysm of the palmar arch was made. He said that four weeks after the fracture he had consulted a dermatologist because the skin of the palm was becoming dark in color and the injured finger was turning blue. Six roentgen treatments had only aggravated the condition.

On admission, the skin of the palm and injured finger presented a typical picture of aneurysm. A very distinct humbebee buzz was noticeable over the site of the old palmar scar. This sound was transmitted up the arm to the elbow and was accompanied by a typical thrill. The veins of the arm were dilated. On the assumption that the aneurysm was due to trauma, he explored the hand and found an arteriovenous aneurysm between the deep and superficial arches. This was dissected out and the surrounding vessels were

tied off. The patient remained well for six months and then began to complain of pain in the hand, so severe that he could neither work nor sleep. The congestion of the veins in the fingers had increased and the humbebee buzz had returned with increased intensity. Roentgenograms showed that the bony openings of the nutrient arteries in the third and fourth fingers were much larger than normal, and that there were progressive atrophy and absorption in the phalanges. A second operation was undertaken, in which the radial and ulnar arteries were ligated and severed and the superficial palmar arch excised. Again, there was an apparent cure, followed within ten months by return of the symptoms. In a third operation, the ulnar and radial arteries, as well as the communicating vessels, were excised down to the pisiform bone, on one side, and into the snuff box on the other. In short, in these three operations the ulnar and radial arteries, and the superficial and deep arches, were excised. The interosseous artery was intact and some of the vessels had split the ulnar nerve in two. The patient remained well for one year and the humbebee buzz did not recur, but he began to have pain and swelling in his fingers. They became extremely painful and deep ulceration appeared on the third and fourth fingers. First, the fourth finger was amputated, then, later, the third. After this he was able to return to work and has remained well during the three and one-half years that have since elapsed, so that there is reason to hope that the cure is permanent.

Summarizing the case, Doctor Lyle said that over a period of five years he succeeded in blocking off some of the congenital arteriovenous openings, with temporary improvement, only to find, after a lapse of time, that other congenital openings had expanded, bringing about recurrence of the symptoms, which ceased only with the final operation described.

DR WM F MACFEE (New York) said that he had not had a case of traumatic aneurysm of the hand, but described a congenital arteriovenous aneurysm which he had treated, in which the communications were evidently multiple. The hand was operated upon a number of times. At each operation one or more definite aneurysmal dilatations were removed only to be succeeded by others developing at other sites. The index and middle fingers became spongy masses of dilated blood vessels and eventually had to be amputated. A considerable mass of palmar vessels near the bases of the fingers was excised at the time of the amputations. At present, the patient is free of symptoms and the circulation of the remaining portion of the hand appears to be relatively normal. There is no palpable or audible thrill and no pain. The sequence of events in this case followed the rule that amputations are necessary to effect relief.

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## PEDICLE BREAST FLAP FOR AMPUTATION STUMP

STRUCTURE SURGERY APPLIED TO AMPUTATION STUMP AT KNEE

JOHANNES F S ESSER, M D

MONACO

**Case Report**—A W, female, age 19, suffered an accidental amputation of her right leg, eight centimeters (three and one-half inches) below the knee joint. The wound would not heal, and no local skin or sliding flaps could be utilized, because of the probable formation of scar contractures. Furthermore, there was not enough of the proximal fragment of the tibia left to allow of a reamputation, without involving the knee joint itself.

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Doctor Oidtman of Amsterdam, under whose care she had been previously and who referred her to me for further structive procedure, had already, ineffectually, attempted to graft skin from the adjacent leg by placing the stump under a raised flap Having



FIG 1—Showing posture necessitated in order to place the amputation stump of right knee in the incision in the right breast

had considerable experience in the use of a pedicle breast flap in successful plastic reconstruction of deformities during the past 15 years, I determined to employ this procedure in the present instance



FIG 2—Showing more in detail, the manner of the approximation of the knee to the breast incision

The skin covering the female breast is much more ample than on any other part of the body, in fact, the reduction of it is considered a cosmetic

# PEDICLE BREAST FLAP

advantage by many, and if one should wish the normal breast to be reduced in size, to conform to that of the partially amputated one, it can be readily accomplished. Indeed, it is seldom that, normally, both breasts are symmetri-

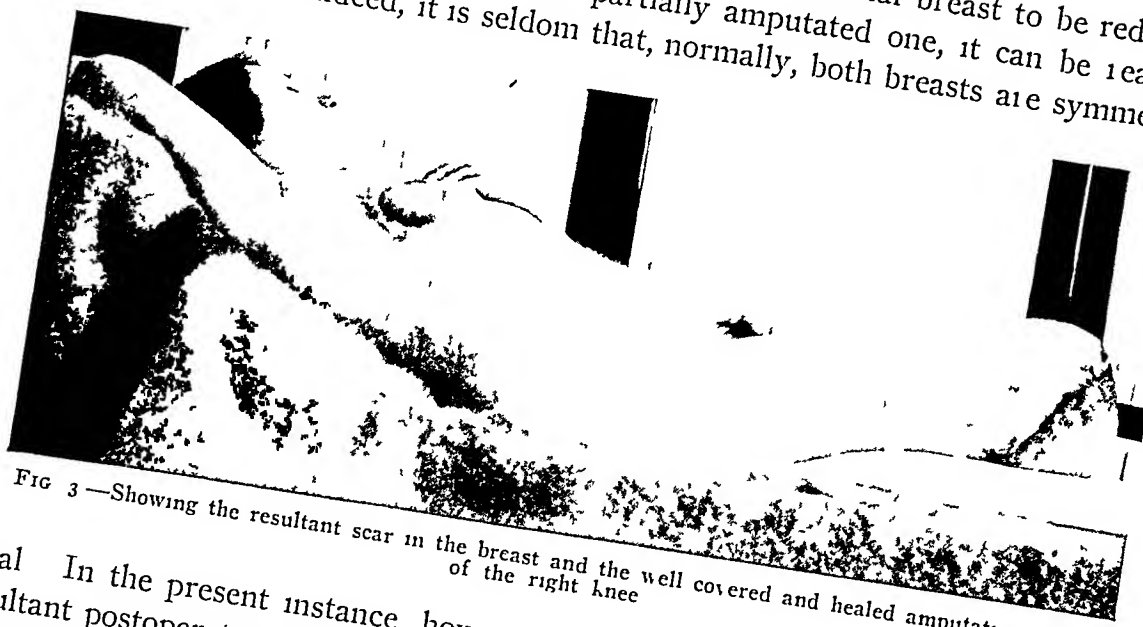


FIG 3—Showing the resultant scar in the breast and the well covered and healed amputation stump of the right knee

In the present instance, however, the patient did not object to the resultant postoperative deformity and refused to have it corrected and a plastic performed upon the normal one in order to make them equal in size

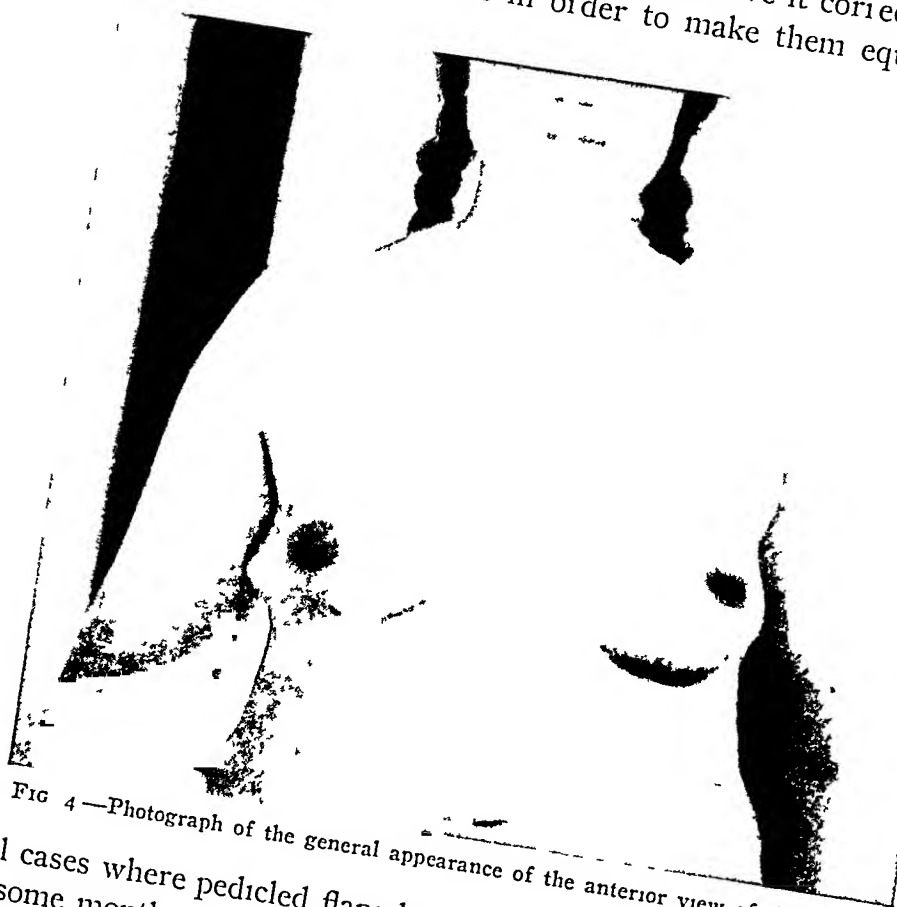


FIG 4—Photograph of the general appearance of the anterior view of the breasts

In all cases where pedicled flaps have been utilized, after severance of the pedicle, some months must be allowed to elapse after the transplantation has been accomplished before the weight of the body should be allowed to press

upon it, and the first exercises with the use of a prosthesis must be undertaken very gradually

The transplanted flap is at first quite insensitive and its circulation is definitely impaired, therefore, in the beginning, the limb may only be exercised for very short periods at a time, and then only under rigid supervision. The primary requisite is to have an accurately fitted prosthesis which may only be obtained from a plaster mold of the healed stump.

The patient in question had, in the beginning, small ulcerations on the stump, the result of local pressure necrosis, because she used her leg too much and too soon. This may have been predisposed to because of abnormal perspiration of the affected leg.

A strictive operation, as indicated in the illustrations, was performed in August, 1925. Ten years have now elapsed and the end-result is quite evident. She is quite content with her infirmity and is otherwise well.

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## PEDICLE GRAFT OF SOLE OF FOOT\*

WM CRAWFORD WHITE, M D

NEW YORK

**Case Report**—S. R., age 21, male, was injured 17 years ago in an automobile accident. He was admitted to the Lincoln Hospital suffering from multiple compound fractures of the toes with *Cl. welchii* infection. As a result, he lost his toes and considerable skin. The skin of the plantar surface posterior to the transverse arch became gangrenous and died. A skin graft operation was not permitted. It took six months for the raw areas to become covered over with thin epithelium on the plantar surface, with no soft tissue beneath. From then on, the patient had constant trouble with his foot. Ulcers formed and persisted for months, and infections were not infrequent.

Examination showed marked deformity of the right foot. The ankle joint was normal, as was the skin over the Achilles tendon. Hard skin was attached to the heel and sole of foot. He wore a shoe with a lining of rubber sponge and walked on the ball of his foot, with a slight limp. It was decided to apply a full thickness graft to the under surface of the foot, including the posterior surface of the os calcis. The delayed tubular graft was the method of choice.

At the Roosevelt Hospital, therefore, two parallel incisions eight inches long were made on the anterior surface of the left thigh. The subcutaneous tissue was freed from the underlying muscle sheath, after which the wounds were sutured. Fifteen days later, the oblong skin was folded under and the edges sutured to make a tube. This tubular graft was allowed to heal and nothing more was done for four months, because of a slight infection. At the end of that time, he had a tube about one inch in diameter and eight inches long. The skin was soft and pliable. At this operation, the distal end of the tube of skin was divided and the undersurface was split longitudinally and the edges everted. It measured two inches across. This was outlined against the sole of the foot. A corresponding area on the sole was then excised down to the plantar fascia. The right foot was now placed against the left thigh and the flap of skin sutured so as to cover over the raw area. The skin was covered with silver foil and rubber sponge pressure pads were applied over this. The limbs were held together by plaster bandage.

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Ten days later rubber covered stomach clamps were applied to the thigh end of the tubular graft to test the circulation. The clamp was left on for progressively longer periods. By the eighteenth day it was thought that the graft had taken and the skin was divided at its junction with the thigh. The tube was opened and the corresponding area over the heel was marked out and excised. The graft was then sutured over the raw area. There was some necrosis, but very little. A few days later the patient was allowed home on crutches.

It is now five months since the operation. Sensation has begun to return, although pain and temperature reactions have not yet reappeared. About two months ago I thoughtlessly gave the patient permission to walk, and due to lack of sensation he developed a pressure sore over the heel which took a long time to heal.

The condition is unusual, chiefly because of the trouble the patient had as there was no soft tissue under the skin, and illustrates the satisfactory results that may be obtained with the Gillies' delayed tubular, full thickness graft.

DISCUSSION—DR JEROME P WEBSTER (New York) expressed the opinion that Doctor White had exercised very good judgment in not using free grafts, but a pedicle flap with a whole thickness of skin and fat, in order to give a pad to the bearing surface, particularly over the os calcis, and a delayed graft which increased the vascularization. A Gillies' tubular, pedicle flap is better in certain instances, even though it takes more time, because it avoids any possibility of infection. Frequently with a short tubed, pedicle flap, it is not possible to utilize as wide an area as when employing a simple, untubed flap. The difficulty with the latter is, of course, the added risk of infection. It is often possible to use a delayed, untubed pedicle flap which is retrograde, that is, the attachment is down toward the knee rather than up toward the hip. After delaying it in order to get a better vascular supply, it is brought further down so that the position is easier on the patient. As far back as 1497 Benedictus cautioned against the effect of the cold of winter on a new flap, and against pulling it off. The ulcer that occurred when Doctor White's patient put weight on the flap, before there was innervation to enable him to realize what pressure was doing to the flap, was a simple trophic ulcerative process.

DR FENWICK BEEKMAN (New York) described a series of traumatic injuries, in Bellevue Hospital, in children whose feet had been crushed or the skin avulsed from the foot, and said that when, invariably, the loose phalanges had been removed and the foot left to granulate, the wounds would be pinch grafted after they had cleaned up, and would then heal. However, as the skin lay almost directly upon the bones, this procedure always proved to be unsatisfactory. Therefore, the method described by Doctor White has been used, that is, after the free grafts are put on, pedicle grafts are later applied to cover, more or less, the whole of the area, but especially those areas covering the bearing surfaces which are bound to break down. No attempt is ever made to place them on the granulation tissue for that would be too precarious. It is far preferable to wait until healing has taken place.

## FRACTURE-DISLOCATION OF THE CLAVICLE\*

FENWICK BEEKMAN, M D

NEW YORK

THE appended case report is presented to demonstrate the power of repair which occurs in children, following fractures, and also the ability to reproduce portions of bone which have been destroyed as the result of trauma

**Case Report**—W E, age 11, a school boy, was injured October 9, 1935, by being crushed against a building by a truck, pinning his shoulder against the wall. He was admitted to Bellevue Hospital shortly after the accident, suffering from severe shock. On examination it was found that there was a lacerated wound over the left clavicle, which was actively bleeding. A clinical diagnosis was made of a compound comminuted fracture of the clavicle without protrusion of the bone through the wound. A large dressing was applied over the clavicle, which was bound tightly over the wound, and the boy was treated for shock.

*Roentgenologic Examination* demonstrated a fracture through the middle third of the left clavicle and a complete dislocation of the outer end of this bone. The distal fragment was composed of almost one-half of the clavicle and had been displaced so that it lay in a vertical position. There was also present a fracture of the glenoid fossa with the fracture lines running into the body of the scapula, with slight displacement of the fragments (Fig 1).

A disagreement developed among the members of the staff as to what procedure would insure a satisfactory result. Forty-eight hours after the accident a tremendous hematoma had formed in the clavicular region and there was still some blood draining through the small wound over the clavicle. It was feared that the displaced fragment had lacerated the subclavian vein and, therefore, that a conservative course of treatment should be followed. Traction was applied to the left humerus by means of skin traction straps to which a five pound weight was attached, and the arm abducted to 90°. It was felt by some of the staff that we should do something to correct the displacement of the fragment. Some wished to cut down upon it and excise it, others wanted to replace it and wire its distal end to the acromion process. We, however, continued to treat the condition conservatively.

On November 8, 1935, 30 days after the accident, the traction was removed and we were surprised to find that the boy could use his arm perfectly. A roentgenogram taken 30 days later showed a bridge of new bone forming between the distal end of the proximal fragment and the acromion process (Fig 2). Measurements of the lengths of the clavicle on both sides showed a shortening of only one centimeter on the left side. The boy was discharged December 23, 1935, at which time the new bone forming the distal half of the clavicle had become dense and signs of erosion of the old fragment could be clearly seen in roentgenograms. Since then this erosion has continued and the size of the loose fragment is but one-third of what it was originally (Fig 3). There seems no doubt that in a year's time this fragment will have entirely disappeared. Meanwhile the fracture of the glenoid fossa had completely healed without deformity, but in a recent roentgenogram an opening or hiatus is seen in the body of the scapula.

The boy now has normal function, and measurements show no shortening of the bone. Palpation of the clavicle reveals a mass extending into the supraclavicular fossa which is caused by the formation of new bone beneath the periosteum, which was raised up in a ridge by the displacement of the fragment.

\* Presented before the New York Surgical Society, May 13, 1936. Received for publication June 17, 1936.



## FRACTURE-DISLOCATION OF CLAVICLE

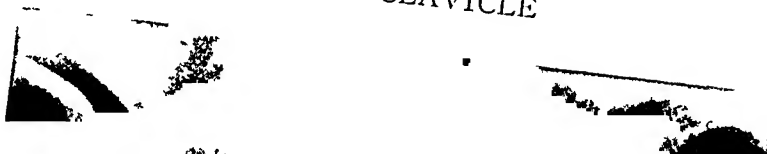


FIG 1—Roentgenogram showing a fracture dislocation of the outer third of the clavicle and a fracture of the neck of the scapula

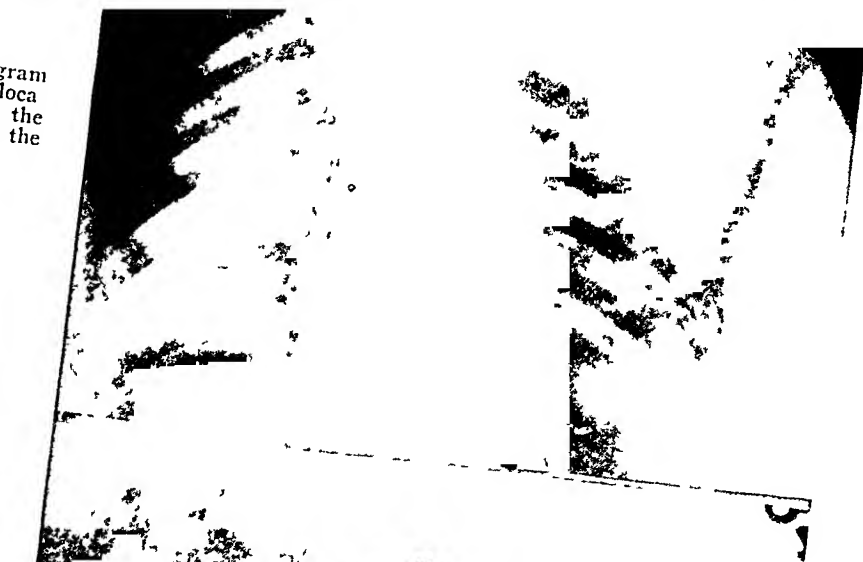


FIG 2—Roentgenogram showing the condition eight weeks after the accident. Note the formation of new bone between the inner fragment and the acromion process



FIG 3—Roentgenogram showing the condition 28 weeks after the accident. A new clavicle has been formed. The displaced fragment is undergoing absorption

Inquiry may be made as to what effect this accident may have had upon the growth of this bone. This to me was at first a question of some importance until it was recalled that the clavicle has but one epiphyseal cartilage which is situated at its sternal end.

I think this case demonstrates the power of a growing bone to replace loss in its continuity, and that in many cases a conservative course of treatment is wiser than the undertaking of a radical procedure, before it is known what nature may accomplish.

DISCUSSION.—DR CARL G. BURDICK (New York) congratulated Doctor Beekman on his conservatism, adding that he and Doctor Beekman had had the opportunity of seeing a good many fractures in children and that while, every now and then, they were quite surprised at the final results in cases of marked displacement, he doubted if they had ever been more pleased than by the results obtained in this particular case. If one looks at the roentgenogram carefully, it is possible to see a bridge of periosteum along which the new bone is being laid down. He believed that eventually the displaced fragment would be absorbed. One sees quite often in supracondylar fractures of the elbow with a considerable posterior displacement, the bridge of periosteum between the displaced fragment and the shaft with new bone being laid down along it, followed by absorption of the displaced proximal fragment, generally with hardly any evidence of fracture at the end of two or three years. When one has observed many of these cases there is a tendency to become a little too conservative. It is important to appreciate the difference between fractures with considerable displacement of the shaft of the bone and fractures involving the joints. Comparing greenstick fractures, where there is a considerable amount of bowing, with fractures of both bones of the forearm with marked displacement and considerable overriding, one finds that cases of marked bowing take very much longer to correct themselves than do those where there is a complete fracture with considerable displacement and overriding.

DR JOHN J. MOORHEAD (New York) referred to the possibility of there being shortening on account of involvement of the epiphysis. Contrary to the general belief, he said that it is very difficult to recall a case of long bone fracture in a child in which, even with considerable involvement of the epiphysis there had been lasting changes. In trying to review these, as Doctor Beekman presented his case, Doctor Moorhead said the only cases he could think of in which ultimate function is lacking is in fracture of the lower end of the femur, in which one is much more likely to have epiphyseal changes than in any of the other bones.

DR CLAY RAY MURRAY (New York) emphasized the benefits of conservative treatment in fractures in children. Regarding the question of whether permanent damage is or is not rare in epiphyseal injuries, he said that he had had occasion to see epiphyseal separation result in permanent damage. In a recent careful follow up at Presbyterian Hospital, it was found that between 4 per cent and 5 per cent of cases with an epiphyseal separation showed damage with deformity, and that while approximately 75 per cent of these, after a period of years, were normal, 25 per cent—or 1 per cent of all epiphyseal separations—showed permanent deformity requiring operative intervention.

DR FENWICK BEEKMAN (New York) in closing said that the healing of fractures in children is quite different from that of fractures in the adult. The periosteal tube is a very important factor in the production of a new shaft. Some years ago he presented before the New York Surgical Society a supracondylar fracture with a great amount of displacement of the lower fragment in which a new shaft was being formed to connect up with the displaced epiphysis of the humerus, while the old shaft was being absorbed. That child did not have full function until two years after the injury because of the presence of the old shaft. Of course, the epiphyseal side is the site where, in all probability, the proliferation of cartilage cells occurs. Therefore fractures that cut across epiphyseal cartilage are those in which we most often find interference with growth, and where a fracture does involve the epiphyseal cartilage one should always give a poor prognosis. In those which do not involve it there is no danger whatever of interference with growth. Regarding epiphyseal injuries, Doctor Beekman said that he has had the opportunity to see a large number of fractures, in which the fracture line was not shown in the film, but where the cartilage of the epiphysis has been injured together with injury of the capitulum or the trochlear, and the proliferating cells were involved, yet when these children were discharged from the hospital there was no deformity. However, many returned after four or five years with marked valgus or varus deformities, due to damage of the trochlear or capitulum growth centers, this is also true of certain cases of separation of the lower epiphysis of the radius, but in these cases one can see the fracture line running across the epiphyseal cartilage. Doctor Beekman said he was very much opposed to operation upon dislocations of the epiphysis of the lower end of the radius, for the simple reason that they all straighten out if one gives them time. On the other hand, if one goes in with his chisel he may injure the proliferating cells of that plate. Regarding the possibility of shortening in the case presented, when the boy left the hospital he had less than 1 cm shortening. When examined one week ago, this had been diminished to less than 5 cm and this will probably not increase. In fact, the epiphyseal cartilage plate at the sternal end may be stimulated so that eventually this injured side may actually be longer than the other.

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## HIGH INTESTINAL FISTULA

### A METHOD OF TREATMENT

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THE management of a duodenocutaneous fistula or any other type of high intestinal fistula requires the surgeon's best effort. There are two serious complications that must be guarded against. One is the resultant alkalosis or acidosis depending upon the location of the fistula and associated with the loss of salts in body fluids. Such loss unless replaced continuously by physiologic solutions leads to death. The second complication is a severe excoriation of the skin and deeper structures of the anterior abdominal wall by the intestinal juices.

This skin reaction is of a chemico-inflammatory type characterized by erosions terminating in slough. The phenomenon is due to enzymic digestion and may or may not be accompanied by bacterial contamination. Co-Tui<sup>1</sup> has demonstrated on a qualitative and quantitative basis that all skin excoriations of surgically produced intestinal fistulae are due to tryptic digestion varying in concentration in the fistular discharge from 200 trypsin units (sigmoidostomy) to 2,000 trypsin units (cecostomy). The higher the location of the fistula the greater the loss of intestinal enzymes, and the more marked the effect on the skin surface.

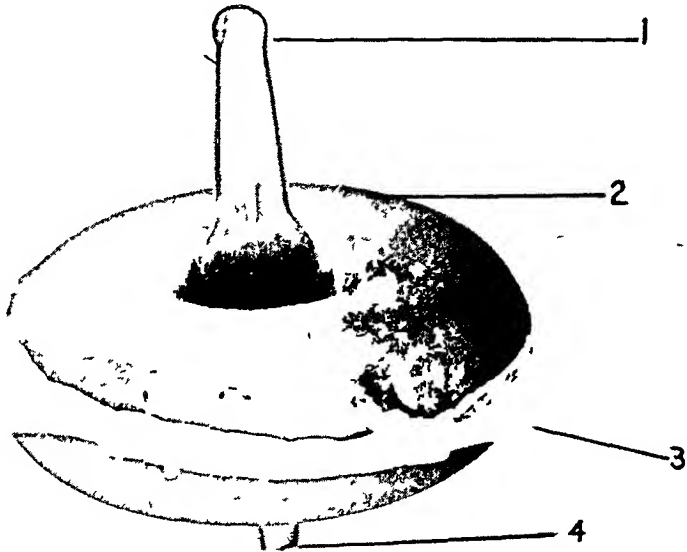


FIG. 1.—Close range view of fistula belt. (1) End of Murphy drip tube for attachment to suction. (2) Rubber pessary ring. (3) Moleskin bandage sewed around rubber ring. (4) End of Murphy tube which fits into fistulous stoma.

A high cutaneous fistula occurs usually after surgery upon the stomach, duodenum, or jejunum. With the increase of plastic surgical procedures on the gastro-intestinal tract, the incidence of fistula has increased. The latter complication becomes apparent usually after the fourth postoperative day, and is due to leakage from the intestinal suture line, unnoticed trauma to intestinal tissue from pressure clamp or fistulization from improperly located drain. Immediate surgical repair by direct suture or side-tracking anastomosis is never indicated because of the high mortality (50 per cent) directly related to the patient's poor general condition.

Conservative therapy offers the best prognosis. Appended is a brief review of the various efforts directed to prevent the skin excoriations, which, if not controlled, assume vast proportions and may quickly involve the entire abdominal wall. The type of treatment of a fistula may be either mechanical or chemical. The chemical methods are usually of three types. Potter<sup>2</sup> recommends a beef preparation which is placed about the stoma of the fistula.

and encloses decinormal hydrochloric acid introduced directly into the opening of the sinus. Co-Tui<sup>3</sup> popularized the use of kaolin, which is a colloidal absorbent, for the electronegative trypsin. Various methods for the mitigation of the area about the cutaneous fistula with antacids or antalkalis, to inactivate the ectopic enzyme, are also recommended. The mechanical methods consist principally of the removal of the fistular contents by means of suction (Cameron,<sup>4</sup> Lahey<sup>5</sup>). Einhorn recommends the passage of a duodenal tube beyond the opening of the fistula with feeding by this method. Others have tried to plug the external opening of the sinus and have met with varying degrees of success.

We report a method of treating high intestinal fistulae which embraces both mechanical and chemical means. We find that chemical methods alone without suction are inadequate. The device described has been used successfully on four cases.

#### ILLUSTRATIVE CASE REPORT

Patient J. H.—On the fifth day following a plastic gastro-intestinal repair for duodenal ulcer, a discharge was noted on the dressing. This was at first believed to be a simple wound exudate but proved to be intestinal juice, and the existence of a fistula was appreciated. Direct plugging of the fistula failed. Potter's beef preparation did not seem to restrict the excoriation which was rapidly spreading. The patient's condition was precarious. It was estimated that he lost from one to three liters daily of intestinal juices through the fistula. Continuous intravenous infusion barely replaced the fluid loss. Though an intern was detailed solely for the management of this case, the excoriations progressed, involving the entire surface of the abdomen and were extending up onto the chest wall. Five pounds of kaolin were used daily for dressings which were changed hourly but which proved quite inefficacious. Suction as obtained from the usual operating room electric apparatus was not feasible because of the pain evidently caused by excessive suction pulling on the intestine.

The following apparatus was finally elaborated. It consisted of a Wangensteen suction which seemed to give "physiological" suction and at no time caused pain. A soft

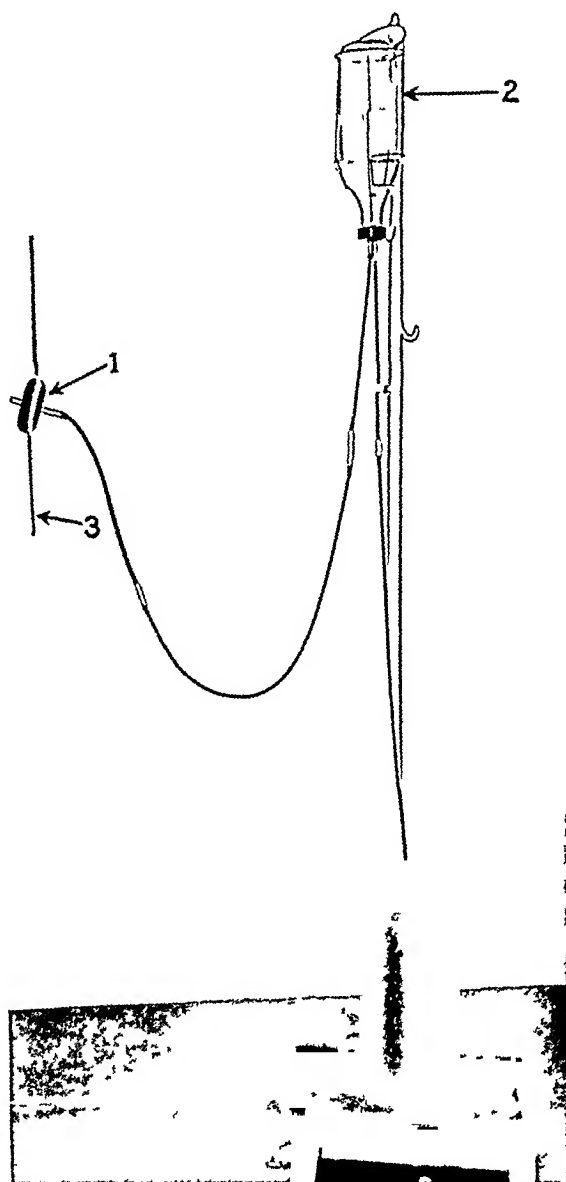


FIG 2—Showing fistula belt attached to suction ready to be applied. (1) Rubber pessary ring containing Murphy drip tube. (2) Wangensteen suction. (3) Moleskin belt sewed onto rubber ring.

rubber pessary, which resembles a doughnut in appearance (Fig 1) was placed about the fistular opening. To its side was sewn muslin bandage, or adhesive was attached. The belt was fixed by tying it around the patient's back. The hole of the pessary lay directly above and coincided with the stoma of the fistula. Tightly fitted into the pessary was a Murphy drip glass cannula, the tip of which just dipped into the fistula about a centimeter below the skin surface. The outer end of the cannula was connected to the Wangensteen suction (Fig 2). About the large circumference of the pessary a small amount of kaolin was heaped. This method worked satisfactorily. It was in continuous use for three weeks. The progressive erosion of the skin ceased and spontaneous healing ensued. After a week, the patient was allowed food by mouth. It was interesting to see him start the action of the suction by opening the valve of the Wangensteen tube whenever he felt the escape of juices onto the skin, or stop the suction when he felt dry. The sinus closed spontaneously.

## SUMMARY

(1) A simple method, combining the advantages of mechanical and chemical means, for the prevention of skin excoriation, and the closure treatment of high intestinal fistulae, is reported.

(2) It has been satisfactorily employed in four cases.

## REFERENCES

- <sup>1</sup> Co-Tui, F. Excoriations Around External Gastro-Intestinal Fistulae. *ANNALS OF SURGERY*, 98, 242, 1933.
- <sup>2</sup> Potter, C. Treatment of Duodenal Fistulae. *J A M A*, 88, 899, March 19, 1927.
- <sup>3</sup> Co-Tui, F. Kaolin in the Treatment of External Gastro-Intestinal Fistulae. *ANNALS OF SURGERY*, 91, 123, 1930.
- <sup>4</sup> Cameron, A. L. The Treatment of Duodenal Fistula. *Surg, Gynec and Obstet*, 37, 599, 1923.
- <sup>5</sup> Lahey, F. H. The Treatment of Duodenal Fistulae by Suction. *Surg Clin N Amer* 4, 1489, 1924.

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## SURGERY IN PATIENTS OF ADVANCED AGE

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THE medical profession is well aware of the immediate usefulness of their many recent discoveries, but I doubt if many of them are conscious of the more remote effects of these discoveries on society and specifically of their influence in changing the various aspects of the practice of medicine

Any change in the age composition of the population must influence business, politics, philosophy and the practice of medicine. We are in the midst of an amazing change in the age composition of the population of this country, which makes it worth while to have something more than a purely personal interest in the diseases of advanced life

In 1850, life expectancy in this country was about 39 years for white males and 40 years for white females. In 1931, the average duration of life had increased to nearly 59 years for white males and to more than 62 years for white females. In New Zealand, in 1931, the average expectancy of life had reached the amazing figure of 65.04 years. This increase in total life expectancy is due, for the most part, to the great reduction in infant mortality, but there has been some reduction in the mortality rates of all ages of white males up to 55 years, and all ages of white females.

Associated with this decrease in mortality rate there has been a significant decrease in the birth rate, and the simultaneous operation of these two factors produces an inevitable shift in the age composition of the population towards the higher ages. In 1850, 2.6 per cent of the population were over 65 years of age. In 1931, 5.4 per cent of the population were over 65 years old. If the present trend continues for the same period as the present life expectancy period, the population will then contain 18.5 per cent, or more than 28 million men and women above the age of 65 years.<sup>1</sup> Or, stated another way. A white male citizen 35 years old in 1937, and subsequently realizing his life expectancy, will find himself in 1970 one of twenty-two and one-half million citizens of the United States who are as old or older than he. This is in contrast with the half million in 1850 or the three and one-quarter millions in 1900 (Table I).

An appreciation of this aging of the population impels an interest in the distribution of diseases in the advanced ages and particularly in the various methods of prevention and treatment of diseases peculiar to old age. The

half million old men and women of 1850 could be told that they were too old to be operated upon, but in 1950 the twelve and one-half millions of corresponding ages will consider themselves too young to be so carelessly dealt with

TABLE I

AGE COMPOSITION OF THE POPULATION<sup>1</sup>

Observed for 1850, 1900, and 1930, and calculated for 1950 and 1970

Year	Total Population (Millions)	Under 20 Years (Millions)	Ages 20-49 Years (Millions)	Ages 50-64 Years (Millions)	Ages 65 and Over (Millions)
1850	23 2	12 1	8 9	1 4	0 6
1900	76 0	33 7	32 0	7 1	3 1
1930	122 8	47 6	54 0	14 4	6 6
1950	138 3	40 1	63 2	22 4	12 5
1970	151 4	40 6	59 8	28 6	22 4

This paper is a brief summary of the immediate and remote results of operative treatment of patients more than 70 years of age in the Vanderbilt University Hospital during the period from 1926 to 1935, inclusive. During this period there have been 41,000 admissions, 15,181 operations have been performed in the general operating rooms, and approximately 9,000 operations on the eye, nose and throat have been carried out in a special operating room used by the ophthalmologic and otolaryngologic divisions. Minor operations performed in the ward dressing rooms and the outpatient service have not been included. Two hundred ninety-three operations have been performed on 287 patients over 70 years of age. All of these patients except two have been traced until the date of death or the age attained in 1936. One hundred thirty-six of these patients were living in 1936.

The tables show the nature and incidence of the disease treated by operation. A brief summary of the records of all the patients dying in the hospital is given. After obtaining definite information concerning the subsequent course of the 251 patients discharged from the hospital, some method of evaluation of the duration of life was sought. In dealing with a group of patients over 70 years of age, it must be remembered that life expectancy is short and that there are relatively large changes in the life expectancy of successive ages. On the other hand, the gross error in estimating probable duration of life in an individual instance or in a small group is certainly less if this individual or group is in the higher rather than in the lower age class. In dealing with such small groups, it was not considered worthwhile to use separate tables for white and colored, male and female. The American Experience Life Table was chosen as a standard for estimating life expectancies, because this table is the one most widely used in spite of its rather vague foundations (Table II).

The seventieth birthday was chosen as the beginning of old age, not only because this age has since the beginning of history marked the span of life, but also because it did not seem appropriate to include in old age, individuals who had only just reached the average duration of life. It seemed, also,



# SURGERY IN ELDERLY PATIENTS

TABLE II  
AMERICAN EXPERIENCE LIFE TABLE

Age	Complete Expectation of Life	Age	Complete Expectation of Life
70	8 48	80	4 39
71	8 00	81	4 05
72	7 55	82	3 71
73	7 11	83	3 39
74	6 68	84	3 08
75	6 27	85	2 77
76	5 88	86	2 47
77	5 49	87	2 18
78	5 11	88	1 91
79	4 74	89	1 66

that selecting only patients over 70 would be more significant in showing a trend than if those between 65 and 70 were included Bailey<sup>2</sup> summarized the previous literature on surgery in the higher age classes in his report of the results of operations upon 185 cases over 60 years of age Only 51 of these cases, however, were over 70 years of age More recently, Morton<sup>3</sup> has reported the results obtained in operations on 29 cases over 70 years old Both of these authors believe that there is little evidence for the truth of the popular belief that advanced age is a strong contraindication for the employment of operative treatment Morton, I believe, quite correctly attributes the credit to the urologists for demonstrating that operative treatment could be successfully carried out in individuals of advanced age even in the presence of infection and advanced renal insufficiency from urinary obstruction by enlargement of the prostate

TABLE III  
OPHTHALMOLOGIC OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Operation for cataract	47	1	22	0	14	1	11	0	0	0
Iridectomy	4	0	3	0	0	0	1	0	0	0
Operation on eyelid	5	0	3	0	2	0	0	0	0	0
Enucleation of eye	6	0	3	0	3	0	0	0	0	0
Transplantation, pterygium	2	0	2	0	0	0	0	0	0	0
Extraction foreign body	1	0	1	0	0	0	0	0	0	0
Totals	65	1	34	0	19	1	12	0	0	0

Deaths—1

White, male, 79 Cataract extracted Developed fever seventh postoperative day  
Died within 24 hours Autopsy —Coronary occlusion, with infarction

## Length of Life

Life expectancy, entire group	414 6 years
Life expectancy, group discharged from hospital	409 9
Life realization, entire group	239 5}
Life expectancy, survivors in 1936	180 4}
	419 9

TABLE IV

## OTOLARYNGOLOGIC OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Mastoidectomy	2	0	1	0	0	0	1	0	0	0
Excision tumor larynx	2	0	2	0	0	0	0	0	0	0
Drainage frontal sinus	1	0	1	0	0	0	0	0	0	0
Excision nasal polyp	1	0	1	0	0	0	0	0	0	0
Totals	6	0	5	0	0	0	1	0	0	0

*Deaths—0**Length of Life*

Life expectancy, entire group		44 2 years
Life realization, entire group	37 4	
Life expectancy, survivors in 1936	22 8	60 2

TABLE V

## GENITO-URINARY OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Two stage prostatectomy	29	3	14	1	14	1	1	1	0	0
Perineal prostatectomy	2	0	1	0	1	0	0	0	0	0
One stage prostatectomy	1	0	1	0	0	0	0	0	0	0
Resection of prostate	11	0	6	0	2	0	3	0	0	0
Suprapubic cystostomy for benign hypertrophy	8	6	2	2	3	2	0	0	3	2
Suprapubic cystostomy for cancer prostate	4	3	1	1	3	2	0	0	0	0
Suprapubic cystostomy for stone in bladder	4	0	2	0	0	0	0	0	2	0
Suprapubic cystostomy for cancer bladder	1	0	1	0	0	0	0	0	0	0
Suprapubic cystostomy for ruptured bladder	1	1	0	0	0	0	1	1	0	0
Suprapubic cystostomy for carcinoma urethra	1	1	1	1	0	0	0	0	0	0
Excision urethral caruncle	1	0	0	0	1	0	0	0	0	0
Nephrectomy (carcinoma)	1	1	1	1	0	0	0	0	0	0
Excision hydrocele	4	0	4	0	0	0	0	0	0	0
Totals	68	15	34	6	24	5	5	2	5	2

*Deaths—15*

- (1) Male, white, 70 Benign hypertrophy prostate Two stage prostatectomy Acute parotitis, sixth postoperative day Died ninth postoperative day No autopsy
- (2) Male, white, 79 Benign hypertrophy prostate Two stage prostatectomy Progressive fall in blood pressure Died from pneumonia fourteenth postoperative day Autopsy—Bronchopneumonia

## SURGERY IN ELDERLY PATIENTS

- (3) Male, white, 82 Benign hypertrophy prostate Two stage prostatectomy Died suddenly five weeks after operation Autopsy—Coronary occlusion
- (4) Male, white, 74 Benign hypertrophy prostate Suprapubic cystostomy Abrupt rise in temperature third postoperative day Died sixth postoperative day No autopsy
- (5) Male, colored, 74 Benign hypertrophy prostate Severe urinary infection Irrational Suprapubic cystostomy Died sixth postoperative day No autopsy
- (6) Male, colored, 76 Benign hypertrophy prostate Urethral bleeding Suprapubic cystostomy Death in 24 hours Autopsy—Fibroma prostate, pyelonephritis, bronchopneumonia, pleural effusion
- (7) Male, white, 77 Benign hypertrophy prostate Suprapubic cystostomy Progressive decline until death on thirty-eighth postoperative day Autopsy—Coronary occlusion
- (8) Male, white, 86 Benign hypertrophy prostate Acute retention urine Suprapubic cystostomy Died from pneumonia, third postoperative day No autopsy
- (9) Male, colored, 88 Benign hypertrophy prostate Acute retention urine 18 hours Suprapubic cystostomy Died within 36 hours Autopsy—Thrombosis pulmonary artery, general peritonitis
- (10) Male, white, 70 Carcinoma prostate Suprapubic cystostomy Progressive decline until death on fifteenth postoperative day Autopsy—Carcinoma prostate, multiple abscesses kidney
- (11) Male, white, 76 Carcinoma prostate Suprapubic cystostomy Fever continued Died fifth postoperative day Autopsy—Carcinoma prostate with metastases to bladder, seminal vesicles, retroperitoneal lymph nodes Bronchopneumonia
- (12) Male, white, 78 Carcinoma prostate Suprapubic cystostomy Progressive weakness Sharp rise temperature ninth postoperative day Died seventeenth postoperative day Autopsy—Carcinoma prostate, abscess of lung, empyema
- (13) Male, white, 80 Ruptured bladder, traumatic Suprapubic cystostomy Extensive extravasation of urine into suprapubic spaces Died twenty-ninth postoperative day No autopsy
- (14) Male, white, 72 Carcinoma kidney Nephrectomy Died 24 hours following operation Autopsy—Squamous cell carcinoma left kidney with metastases to liver, pancreas, diaphragm, lungs
- (15) Female, white, 70 Radical removal urethral tumor 12 months previously Local recurrence excised Died seventh postoperative day Autopsy—Adenocarcinoma urethra, pyelonephritis, chronic pleuritis

### *Length of Life*

Life expectancy, entire group		408 years
Life expectancy, group discharged from hospital		322 3
Life realization, entire group	142 5}	280 6
Life expectancy, survivors in 1936	138 1}	

TABLE VI  
ABDOMINAL OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Exploratory laparotomy, inoperable cancer	6	3	5	3	1	0	0	0	0	0
Gastrostomy, cancer esophagus	4	1	3	1	1	0	0	0	0	0
Gastro-enterostomy, cancer	4	2	2	0	2	2	0	0	0	0
Gastro-enterostomy, ulcer	1	0	1	0	0	0	0	0	0	0

TABLE VI—*Continued*

Resection of stomach	1	0	1	0	0	0	0	0	0	0
Closure of perforated duodenal ulcer	1	0	1	0	0	0	0	0	0	0
Laparotomy for perforated gall-bladder	1	1	0	0	1	1	0	0	0	0
Cholecystectomy	7	1	6	1	1	0	0	0	0	0
Choledocostomy	1	0	1	0	0	0	0	0	0	0
Cholecystogastrostomy	1	0	1	0	0	0	0	0	0	0
Appendicectomy, drainage	1	0	1	0	0	0	0	0	0	0
Operation for acute intestinal obstruction	5	3	3	1	2	2	0	0	0	0
Totals	33	11	25	6	8	5	0	0	0	0

*Deaths—11*

- (1) Male, white, 70 Laparotomy Inoperable tumor, hilus of liver Progressive weakness until death on twenty-fourth postoperative day No autopsy
- (2) Male, white, 73 Laparotomy Carcinomatosis peritoneum and liver Progressive weakness until death on twelfth postoperative day No autopsy
- (3) Female, white, 73 Laparotomy Carcinomatosis peritoneum Progressive weakness until death on seventh postoperative day No autopsy
- (4) Female, colored, 72 Carcinoma esophagus Gastrostomy Progressive weakness until death on seventh postoperative day Autopsy—Lung metastases, bronchopneumonia
- (5) Female, white, 77 Large mass of cancer obstructing the pylorus Posterior gastroenterostomy Convalescence uneventful until twelfth postoperative day Sudden onset of chill, fever and intense jaundice Death fourteenth postoperative day No autopsy
- (6) Male, white, 77 Extensive carcinoma pyloric end stomach Posterior gastroenterostomy Died twenty-four hours after operation No autopsy
- (7) Female, white, 75 Laparotomy Gangrene gallbladder General peritonitis Drainage of peritoneum Died two hours after operation Autopsy—General peritonitis
- (8) Female, white, 71 Fistula between gallbladder and duodenum Cholecystectomy Closure duodenal fistula Found dead in bed ninth postoperative day Autopsy—Thrombosis coronary artery
- (9) Male, white, 74 Laparotomy Volvulus of sigmoid, five days' duration Perforation of bowel General peritonitis Died day of operation
- (10) Female, white, 76 Symptoms intestinal obstruction two days Large abdominal mass Colostomy Died fourth postoperative day Autopsy—Dissecting aneurysm abdominal aorta
- (11) Male, white, 79 Acute abdominal pain, nausea and vomiting 2½ days Coronary disease suspected Observed 12 hours Laparotomy Partial obstruction ileum by band Convalescence uneventful until twelfth postoperative day when patient 12 hours after onset had characteristic attack coronary occlusion Autopsy—Coronary occlusion

*Length of Life*

Life expectancy, entire group	233	8 years
Life expectancy group discharged from hospital	161	0
Life realization, entire group	36 4	} 98 2
Life expectancy, survivors in 1936	61 8	

SURGERY IN ELDERLY PATIENTS

TABLE VII  
 HERNIA OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Radical cure ventral hernia	2	0	1	0	1	0	0	0	0	0
Strangulated femoral hernia	2	0	0	0	0	0	1	0	1	0
Strangulated inguinal hernia	6	1	2	0	1	0	3	1	0	0
Inguinal hernia, reducible	10	0	8	0	1	0	1	0	0	0
Totals	20	1	11	0	3	0	5	1	1	0

Deaths—1

Colored, male, 80 Irreducible hernia, one week Cold, pulseless on admission Opera-  
 tive reduction of hernia Death nine hours after operation Autopsy —Mural thrombi  
 right heart, pulmonary infarction, peritonitis, senile changes

Length of Life

Life expectancy, entire group	127	0	years
Life expectancy, group discharged from hospital	122	7	
Life realization, entire group	61	9	} 131 4
Life expectancy, survivors in 1936	69	5	

TABLE VIII  
 MAMMARY GLAND OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Radical mastectomy	3	0	3	0	0	0	0	0	0	0
Simple mastectomy, cancer	5	0	4	0	1	0	0	0	0	0
Excision recurrent cancer	1	0	1	0	0	0	0	0	0	0
Simple mastectomy, chronic mas- titis	1	0	0	0	1	0	0	0	0	0
Totals	10	0	8	0	2	0	0	0	0	0

Deaths—0

Length of Life

Life expectancy, entire group	71	5	years
Life realization, entire group	31	8	} 71 3
Life expectancy, survivors, 1936	39	5	

TABLE IX  
RECTAL OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Hemorrhoids	3	0	1	0	1	0	1	0	0	0
Fistulae	1	0	1	0	0	0	0	0	0	0
Perirectal abscess	1	1	0	0	0	0	1	1	0	0
Benign ulcer rectum	1	0	1	0	0	0	0	0	0	0
Totals	6	1	3	0	1	0	2	1	0	0

*Deaths—1*

White, female, 80 Large perirectal abscess, unknown duration Incision and drainage  
 Temperature continued elevated, pulse rate increased Death on fourth postoperative  
 day No autopsy

*Length of Life*

Life expectancy, entire group	38 2 years
Life expectancy, group discharged from hospital	33 9
Life realization, entire group	40 } 8 }
Life expectancy, survivors in 1936	
	48 0

TABLE X  
NEUROLOGIC OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Operation on gasserian ganglion	8	0	3	0	4	0	1	0	0	0
Craniotomy for fractured skull	2	0	2	0	0	0	0	0	0	0
Laminectomy, chordotomy	1	0	0	0	1	0	0	0	0	0
Totals	11	0	5	0	5	0	1	0	0	0

*Deaths—0**Length of Life*

Life expectancy, entire group	71 0 years
Life realization, entire group	36 2 }
Life expectancy, survivors in 1936	40 4 }
	76 6

TABLE XI  
OPERATIONS FOR CIRCULATORY DISEASE

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Amputation for gangrene	6	1	4	0	2	1	0	0	0	0
Operation for varicose veins	4	1	3	0	1	1	0	0	0	0
Ligation vein for gangrene	1	0	1	0	0	0	0	0	0	0
Totals	11	2	8	0	3	2	0	0	0	0

Deaths—2

- (1) White, male, 77 Extensive gangrene leg one week's duration Guillotine thigh amputation Died 24 hours after operation Autopsy —Marked arteriosclerosis, broncho-pneumonia
- (2) White, male, 75 Chronic ulcer leg excised, using local anesthetic Chill, high fever, seventh postoperative day Died within 24 hours Autopsy —No satisfactory cause of death found

Length of Life

Life expectancy, entire group		77 8 years
Life expectancy, group discharged from hospital		66 0
Life realization, entire group	27 0	33 6
Life expectancy, survivors in 1936	6 6	

TABLE XII  
OPERATIONS FOR SUPERFICIAL NEOPLASMS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Excision epithelioma face	10	1	5	1	4	0	1	0	0	0
Excision melanoma face	2	0	2	0	0	0	0	0	0	0
Excision angio-endothelioma face	1	0	0	0	0	0	1	0	0	0
Excision sarcoma face	1	0	1	0	0	0	0	0	0	0
Cavernous hemangioma face, ligation carotid artery	1	0	0	0	1	0	0	0	0	0
Excision tumor lip	4	0	1	0	2	0	1	0	0	0
Excision epithelioma neck	7	0	4	0	2	0	0	0	1	0
Excision carcinoma gum	3	0	2	0	1	0	0	0	0	0
Excision squamous cell carcinoma hand	7	0	3	0	3	0	0	0	1	0
Excision squamous cell carcinoma vulva	1	0	1	0	0	0	0	0	0	0
Excision mixed tumor parotid	1	0	0	0	1	0	0	0	0	0
Excision tumor chest wall	1	0	0	0	1	0	0	0	0	0
Totals	39	1	19	1	15	0	3	0	2	0

Deaths—I

White, male, 70 Large epithelioma of face destroyed with cautery Died nine weeks later Autopsy —Fibrinopurulent meningitis

Length of Life

Life expectancy, entire group		246 3 years
Life expectancy, group discharged from hospital		237 5
Life realization, entire group	99 0	193 5
Life expectancy, survivors in 1936	94 5	

TABLE XIII

THYROID OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Partial thyroidectomy (hyperthyroidism)	2	1	2	1	0	0	0	0	0	0
Partial thyroidectomy (cancer)	1	0	1	0	0	0	0	0	0	0
Totals	3	1	3	1	0	0	0	0	0	0

*Deaths—1*

White, female, 73 Diffuse toxic goiter Chronic heart disease Partial thyroidectomy  
Died second postoperative day Autopsy—No satisfactory explanation of death

*Length of Life*

Life expectancy, entire group	23 5 years
Life expectancy, group discharged from hospital	16 5
Life realization, entire group	0 16
Life expectancy, survivors in 1936	0 00

TABLE XIV

BONE AND JOINT OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Amputation (tuberculosis tibia)	1	0	0	0	1	0	0	0	0	0
Osteotomy for osteomyelitis (os calcis)	1	0	1	0	0	0	0	0	0	0
Closed reduction (fractures)	8	0	6	0	2	0	0	0	0	0
Open reduction dislocation (car- pal)	1	0	1	0	0	0	0	0	0	0
Totals	11	0	8	0	3	0	0	0	0	0

*Deaths—0*

*Length of Life*

Life expectancy, entire group	79 5 years
Life realization, entire group	30 0
Life expectancy, survivors in 1936	56 6



# SURGERY IN ELDERLY PATIENTS

TABLE XV

## INCISION AND DRAINAGE OF INFECTIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Incision-drainage infection neck	2	1	2	1	0	0	0	0	0	0
Incision-drainage infection buttock	1	0	1	0	0	0	0	0	0	0
Incision-drainage infection, carbuncle	1	0	0	0	1	0	0	0	0	0
Incision-drainage abscess (flank)	1	0	1	0	0	0	0	0	0	0
Totals	5	1	4	1	1	0	0	0	0	0

### Deaths—I

White, female, 74 Extensive infection neck five days' duration Nitrous oxide anesthesia Abscess drained Died suddenly few hours after operation No autopsy Death presumably cardiac

### Length of Life

Life expectancy, entire group	26 9 years
Life expectancy, group discharged from hospital	20 2
Life realization, entire group	5 3
Life expectancy, survivors in 1936	9 8

TABLE XVI

## GYNECOLOGIC OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Oophorectomy (tumor)	1	0	1	0	0	0	0	0	0	0
Dilatation and curettage	1	0	1	0	0	0	0	0	0	0
Anterior suspension uterus	1	1	1	1	0	0	0	0	0	0
Totals	3	1	3	1	0	0	0	0	0	0

### Deaths—I

White, female, 71 Complete prolapse uterus Anterior suspension Irregular daily elevations of temperature until ninth postoperative day, when patient suddenly developed extreme dyspnea Palpable pulse disappeared Died 16 days following operation Autopsy —Extensive bilateral acute bronchopneumonia with pulmonary infarctions

### Length of Life

Life expectancy, entire group	22 5 years
Life expectancy, group discharged from hospital	14 5
Life realization, entire group	7 0
Life expectancy, survivors in 1936	6 2

TABLE XVII

CHEST OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Drainage lung abscess	1	1	1	1	0	0	0	0	0	0

*Deaths—1*

Male, white, 71 On admission, moribund Lung abscess, secondary empyema Em-  
pyema drained Died less than 24 hours postoperative No autopsy

*Length of Life*

Life expectancy, entire group	8 years
Life expectancy, group discharged from hospital	0
Life realization, entire group	0
Life expectancy, survivors in 1936	0

TABLE XVIII

PLASTIC OPERATIONS

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Plastic operation for burn	1	0	1	0	0	0	0	0	0	0

*Deaths—0*

Life expectancy, entire group	8 years
Life realization, entire group	1 1
Life expectancy, survivors in 1936	0 0

TABLE XIX

OPERATIONS IN ADVANCED AGES

Type of Operation	(70-89)		(70-74)		(75-79)		(80-84)		(85-89)	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Ophthalmologic	65	1	34	0	19	1	12	0	0	0
Otolaryngologic	6	0	5	0	0	0	1	0	0	0
Genito-urinary	68	15	34	6	24	5	5	2	5	2
Gynecologic	3	1	3	1	0	0	0	0	0	0
Abdominal	33	11	25	6	8	5	0	0	0	0
Hernia	20	1	11	0	3	0	5	1	1	0
Rectal	6	1	3	0	1	0	2	1	0	0
Mammary gland	10	0	8	0	2	0	0	0	0	0
Thyroid	3	1	3	1	0	0	0	0	0	0
Neurologic	11	0	5	0	5	0	1	0	0	0

SURGERY IN ELDERLY PATIENTS

TABLE XIX—*Continued*

Superficial neoplasms	39	1	19	1	15	0	3	0	2	0
Bone and joint	11	0	8	0	3	0	0	0	0	0
Infections	5	1	4	1	1	0	0	0	0	0
Circulatory disease	11	2	8	0	3	2	0	0	0	0
Chest	1	1	1	1	0	0	0	0	0	0
Plastic	1	0	1	0	0	0	0	0	0	0
Totals	293	36	172	17	84	13	29	4	8	2
	12	3%	9	9%	15	4%	13	7%	25%	

*Length of Life*

Life expectancy, entire group	1900	5 years
Life expectancy, group discharged from hospital	1404	5
Life realization, entire group	795	2
Life expectancy, survivors in 1936	734	2

From the results obtained in this group of 293 operations on patients more than 70 years of age, it appears that surgical diseases in the higher age groups are associated with a relatively high mortality, but that deaths which could be reasonably attributed to operative treatment are remarkably infrequent. In other words, increasing the proportion of patients in the higher age groups in surgical wards would increase the hospital mortality rate, but should not increase the hazard of operative treatment. For example, in the genito-urinary operations, in which group 15, or more than one-third of all deaths occurred, only three patients died who had been considered in sufficiently good condition to have any more than the preliminary suprapubic cystostomy, or nine deaths occurred in patients in whom urinary obstruction made suprapubic cystostomy obligatory and death ensued before operative treatment of the primary disease could be undertaken. Or, to approach this question from another viewpoint, if only those groups of patients are chosen in which some operative procedure was undertaken solely for the purpose of relief of some distressing symptom, caused by a condition which presumably would not necessarily decrease life expectancy, i.e., reducible hernia, cataract, tic douloureux, gallbladder disease (without gangrene or perforation), and benign abnormalities of the rectum, there were 90 cases operated upon with one death from coronary occlusion on the seventh post-operative day. Assuming an average of one month's residence in the hospital, this death rate is approximately the same as occurs in the general population at the age of 75. Life realization of these groups was apparently in excess of that calculated from the American Experience Life Table. These results also cast a considerable amount of doubt on the generally accepted opinion that simple confinement to bed during advanced life is dangerous.

The presence of a malignant tumor was responsible for 72, or 24.5 per cent, of the 293 operations. In 31 of these cases the malignant tumor was about the face or neck, and the frequency with which epithelioma of the dorsum of the hand occurred, seven times, is interesting. In general, the

results obtained in cancer, except intra-abdominal cancer, were remarkably good. In the group of superficial epitheliomata, life expectancy was not alarmingly diminished, and the only death which occurred in the hospital was in an instance of epithelioma of the forehead which had been neglected until extensive invasion of the bone was present. Fifteen of 33 abdominal operations were performed for cancer and six of these patients died in the hospital. Those discharged all died within a year except two who had gastroenterostomies for carcinoma of the pylorus. One of these lived 16 months, and one is alive four years after operation. The latter is probably an instance of mistaken diagnosis.

The group which is most discouraging is that requiring abdominal section. One-third of these patients died in the hospital, and the survivors have realized only a small fraction of their life expectancy. In those patients who died in the hospital, it was obvious that no death could be attributed to an operation. Six patients had inoperable cancer, three were suffering from intestinal obstruction, and one had general peritonitis from rupture of a gangrenous gallbladder. The remaining death which occurred has a particular bearing on the subject of this paper. This patient was first seen in 1925 with gallbladder disease. Because of age, hypertension and complete cessation of symptoms during her stay in the hospital, operation was not advised. The attacks recurred with increasing frequency and severity until 1927, at which time she was admitted in such a condition that operation was unavoidable. The gallbladder was found ruptured into the duodenum. After removal of the gallbladder, convalescence was quite satisfactory for nine days, when the patient died suddenly of coronary occlusion. It seems unavoidable to escape the conclusion that operation should have been undertaken in 1925.

It is also of interest to compare the incidence of some of the surgical

TABLE XX

RELATIVE INCIDENCE OF OPERATIVE PROCEDURES FOR SIMILAR CONDITIONS IN PATIENTS  
UNDER SEVENTY AND OVER SEVENTY YEARS OF AGE

Type of Operation	Total Number of Operations	Operations upon Patients over 70 years Old	Percentage
Appendicectomy	975	1	0.1
Thoracostomy	199	1	0.5
Thyroidectomy, partial	369	3	0.8
Cholecystectomy	337	7	2.0
Stomach resection	43	1	2.3
Excision mammary gland, radical	101	3	2.9
Hernia	542	20	3.6
Excision posterior root (gas- serian ganglion)	49	8	16.1
Cataract	195	47	24.1
Prostatic	152	55	36.1
Totals	2,962	146	4.9

diseases occurring after the age of 70 with the incidence of these same diseases in younger patients during the same period. Table XX indicates the relative incidence for a few of the more frequent operative procedures.

There is without doubt a technic for handling sick old people which improves the chance of recovery. Just as there is a personal fitness for dealing with children, there is also an effective attitude to adopt toward the aged. They need to be surrounded with an atmosphere of optimism, and it is perhaps even more important to guard a patient of advanced age against exposure to an acute respiratory infection than to prevent the exposure of a child to a contagious disease. The importance of careful study and pre-operative treatment for existing disease of the heart and kidneys in dealing with patients of advanced age is already generally appreciated.

It is at least amusing to speculate about the effects of the shift in the age composition and the stabilization of the population in number and age composition, on the present set up of specialization in the practice of medicine. In general, the obstetricians and the pediatricians can anticipate a diminution in numbers of births and children. The internists can certainly look forward to an increase in the incidence of the degenerative diseases. The surgeons may reasonably expect an increase in their responsibilities because the incidence of surgical diseases is certainly greater in individuals over 50 than under 20, but this increase in surgical disease will be unequally distributed among the various surgical specialties. The urologists will be a great deal busier with their much larger group of old men, but the gynecologists will probably not be seriously overworked with their even larger group of old women, because gynecologic conditions seem to occur relatively infrequently in the advanced ages. The ophthalmologists may look forward to performing more operations for cataract, but the otolaryngologists will do relatively few operations on the ear, nose and throat to compensate for the diminution in tonsillectomies and adenoidectomies. The orthopedic surgeons, I believe, are already aware of the great decrease in the incidence of tuberculosis of the hip and spine, and I note that orthopedic literature already shows evidence of an intensification of interest in arthritis of the spine. The neurologic surgeon can anticipate a less discouraging field after the addition of the increased number of operations for tic douloureux, and, finally, the plastic surgeon will have more operations for epitheliomata of the face and less operations for harelip and cleft palate.

I leave for your own reflection the results of the aging of that part of the population who are engaged in the teaching of medicine.

#### REFERENCES

- <sup>1</sup> Dublin, Louis I., and Lotka, Alfred J. Length of Life. The Ronald Press Company, 1936.
- <sup>2</sup> Bailey, Fred W. Amer Jour Surg, 24, 487, 1934.
- <sup>3</sup> Morton, J. J. Amer Jour Surg, 30, 92, 1935.

# SUBPHRENIC ABSCESS WITH BRONCHIAL FISTULA \*

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RUPTURE of a subphrenic abscess into a bronchus is a relatively rare occurrence. In 1902, Cauderay<sup>3</sup> collected 20 proven cases of this complication and analyzed them in detail. Since the publication of his thesis, no detailed study has appeared in the literature. In 1909, Piquand,<sup>9</sup> in a collected series of 890 cases of subphrenic abscess, found 112 complicated by a bronchial fistula. Many of his cases, however, were not proven by operation or autopsy. Since 1909, only 13 proven cases have been reported. To these we are adding six cases which were admitted to the University of Michigan Hospital in the ten year period from January 1, 1926, to December 31, 1935. During this same period, a total of 48 cases of subphrenic abscess were operated upon or autopsied in this hospital.

*Incidence*—The incidence of all pulmonary complications of subphrenic abscess was found by Ochsner and Graves<sup>7</sup> to rise with delayed diagnosis and treatment. The incidence of rupture of subphrenic abscess into a bronchus in our collected series of cases was 11.8 per cent. In our own series it was 12.5 per cent. The frequency of this complication in various series depends to a large extent upon the length of the period between the formation of the abscess and the time that the patient is first seen in the reporting clinic. Many cases of subphrenic abscess are admitted to the University of Michigan Hospital late in the course of their disease. Half of our cases with bronchial fistula were admitted after the rupture into the bronchus had occurred.

In reviewing a series of 60 perinephric abscesses admitted to the same hospital during a corresponding period of time, Nesbit and Keene<sup>6</sup> found six cases with bronchial fistula. They attributed the high incidence of this complication (10 per cent) to the delay in diagnosis and consequent delay in treatment.

*Pathology*—The course the pus follows after perforation of the diaphragm depends on whether or not a free pleural space exists. If the basal portions of the pleurae are not adherent, perforation will be followed by an extensive empyema, which may rupture later into a bronchus. If, however, adhesions are present, the abscess will rupture directly into the lung or a small, localized empyema may be formed, which, in turn, will rupture into the lung. We were able to demonstrate this in two of our cases, once at autopsy (Case 5) and once at operation (Case 6). These empyemata were so small that they could not be diagnosed either clinically or roentgenologically.

A basilar pneumonitis frequently precedes the rupture of the pus into a

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# SUBPHRENIC ABSCESS

TABLE I  
RESUME OF THE SIX CASES REPORTED

Name	Case No	Sex	Age	Source of Infection	Nature of Abdominal Operation	Time from Onset of Abdominal Symptoms to Rupture into Bronchus	Proof of Subphrenic Abscess	Empyema	Result	Remarks
H M	1	M	39	Acute appendicitis	Appendicectomy R	9 da	Operation	0	Recovered	Inadequate drainage of abscess—prolonged course
D M	2	M	28	Acute appendicitis	Appendicectomy R		Operation	0	Recovered	Treated conservatively for two years—then drained
F M	3	M	29	Unknown	Appendicectomy R	18 mos	Operation	0	Recovered	Sudden death on day of operation
T M	4	M	30	Ruptured appendix	None L	18 da	Operation	0	Died	Localized empyema above perforation of diaphragm
J B	5	M	48	Acute appendicitis	None R	13 da	Operation	?	Recovered	Inadequate drainage of abscess—prolonged course—lived eight years
J G	6	M	43	Unknown intra-abdominal	Appendicectomy R	6 mos	Autopsy	Small	Died	
					None R	14 da.	Operation	Small	Died	

bronchus and becomes intensified immediately following the formation of the fistulous tract. The shadow cast by this pneumonitis is always the most conspicuous roentgenologic finding in these cases but is, of course, not diagnostic of the fistula.

In those cases in which the fistula has been present for a long period of time, patches of chronic pneumonitis and atelectasis may be present throughout the affected lung, due to repeated aspiration of pus into various branches of the bronchial tree.

*Diagnosis*—The cardinal symptom of the rupture of a subphrenic abscess into a bronchus is a sudden coughing attack with the expectoration of a large quantity of pus. This pus usually has an extremely foul odor, which is characteristic of the causative organism, frequently the colon bacillus. The patient may have noticed an appreciable amount of sputum for a varying length of time before such an incident, but this is usually mucopurulent in character and can be accounted for by the pneumonitis existing prior to the rupture of the abscess into the bronchus. The quantity of the sputum following rupture is greatly increased over that produced by the pneumonitis alone and is much more purulent in character.

Rupture of an empyema, not occurring as a complication of subphrenic abscess, into a bronchus may, of course, produce a similar sudden expectoration of pus. The history of previous abdominal disease in the case of subphrenic abscess is often of aid in making a differential diagnosis although, occasionally, the abdominal symptoms may be obscure. Empyema as a complication of subphrenic abscess due to lymphatic extension of the infection rather than to perforation of the diaphragm is a possibility mentioned by Beyer.<sup>2</sup> The rupture of such an empyema into a bronchus would produce a confusing clinical picture.

The length of time between the evident onset of the symptoms produced by the original abdominal focus of infection and the rupture of the abscess into the bronchus is inconstant. In our series of cases this period varied from nine days to 18 months, averaging about 18 weeks. In Cauderay's series, it varied from ten days to 23 months.

Roentgenograms may be of value in establishing the diagnosis of a subphrenic abscess with bronchial fistula. In some instances, the fistula will allow air to enter the abscess and thus produce an air bubble and fluid level beneath the diaphragm that may be identified. Sometimes a bronchogram, or the injection of iodized oil into a sinus leading to an inadequately drained abscess, will demonstrate the fistulous tract, but in other cases the tract is filled with pus and will not allow passage of the oil. In addition, the characteristic roentgenologic findings of subphrenic abscess, such as an elevated and fixed diaphragm, obscuration of the costophrenic angle, *etc.*, may be helpful when correlated with the clinical findings.

*Mortality*—The mortality in the entire 48 cases of subphrenic abscess reviewed was 50.8 per cent as compared with 50.0 per cent in those cases complicated by bronchial fistula. Death in our three fatal cases occurred nine



days, 16 days and eight years, respectively, after rupture of the abscess into the bronchus, the last patient dying of a brain abscess which occurred as a complication of an osteomyelitis of a rib incident to drainage of the abscess which, in itself, had been entirely healed for three months prior to death.

No accurate comparison of the mortality rate in our series and that of the collected series can be made, inasmuch as many of the cases collected by Cauderay and Piquand, which constitute a large majority of the collected series, were not diagnosed before the patients came to autopsy. Many of the cases reported by these two authors occurred before surgical drainage of a subphrenic abscess was a widely practiced procedure. In every one of our cases drainage of the abscess was performed.

*Treatment*—The prevention of a bronchial fistula is evidently concerned with the early diagnosis and drainage of the abscess.

Spontaneous recovery following rupture into a bronchus has been reported<sup>2, 3, 5</sup>. Cauderay, in reporting three cases of recovery without surgical drainage of the abscess, advises against conservative treatment because of the protracted convalescence. One of our cases (Case 2) was treated expectantly for two years but drainage was eventually found to be necessary because of recurrence of purulent sputum.

We advise immediate surgical drainage of the subphrenic abscess as the method of choice in the treatment of this complication. Drainage must be adequate. In two of our cases (Cases 1 and 6), inadequate drainage of the abscess was instituted following rupture into the bronchus. In both of these cases, the fistulous tract remained open until adequate drainage was established. An accompanying empyema should be drained independently.

### CASE REPORTS

**Case 1**—H. M., laborer, age 39, was first admitted to the University Hospital September 4, 1918. In April, 1918, an appendicectomy had been performed at another hospital for gangrenous appendicitis. Convalescence had been stormy and on the seventh postoperative day the patient began to expectorate thick, dark green pus having a very foul odor. On the fifteenth postoperative day, a large right subphrenic abscess had been drained. The patient, however, had continued to expectorate a considerable amount of pus. Twelve weeks after the appendicectomy, bismuth paste was injected into the abscess and was immediately vomited. The drainage tube was removed at this time. The patient was not then raising any appreciable amount of sputum.

Upon admission to the University Hospital, five months after the appendicectomy, the patient was again raising a considerable amount of sputum and complained of severe abdominal pain. A tumor mass was palpated below the right costal margin anteriorly. A roentgenogram revealed radio-opaque material evidently within the subphrenic abscess.

On September 9, 1918, an anterior subphrenic abscess was drained through a high right rectus incision. A large amount of thick, foul, yellowish pus together with some bismuth escaped. The patient was discharged November 4, 1918, with the wound still draining.

This patient was readmitted July 5, 1935, and stated that he had been raising thick, yellow, purulent sputum during the entire 17 years since his previous admission. In the interim, the mass in the right upper quadrant had recurred on several occasions, subsiding, however, following evacuation of pus by bowel. Two weeks before admission, a

fluctuant, superficial mass had appeared in the midepigastic region. This had been incised by his family physician with the evacuation of a moderate amount of pus.

Examination revealed two draining sinuses, one at the level of the eighth rib in the right midaxillary line, and the other in the midepigastic region. Roentgenograms, taken after the injection of iodized oil into the sinus of the right thoracic wall, revealed an irregular and tortuous tract which was seen to extend downward to end in a blind pouch and upward to communicate with a tertiary bronchus of the middle lobe. Stereoscopically, the lower tract appeared to be very superficial and extended in the direction of the recently opened abscess in the epigastrium. There was a faint shadow approximately midway between the thoracic wall sinus and the abscess in the epigastrium. This shadow was believed to be cast by the bismuth paste which had been injected in 1918.

The sinus tract between the axillary and epigastic sinuses was excised in four stages, between July 12, 1935, and January 8, 1936. The right chondral arch was removed and a pocket found which was believed to be the residual subphrenic abscess. A modified Schede thoracoplasty was performed and the lung cauterized in the region of the bronchial fistula. Convalescence from the last stage was complicated by mild cardiac decompensation which, however, was adequately controlled by digitalis. The patient was discharged March 3, 1936, at which time the wound was slowly filling with granulation tissue. All sinuses were entirely healed in July, 1936.

**Case 2**—M. D., farmer, age 28, was admitted to the University Hospital August 24, 1926, complaining of cough with expectoration of large amounts of pus. Fourteen months previously, he had had an appendectomy for acute appendicitis at another hospital. The postoperative course had been stormy, fever persisting for eight weeks. A rectal abscess had been drained several weeks after the appendectomy. The patient had never fully recovered his strength and had had persistent tenderness in the right upper abdomen. Two days before admission, he had had a sudden coughing attack and had expectorated about a pint of foul, grayish-brown pus within a few minutes.

Upon admission the patient's temperature was 102° F and he was coughing continuously. There was marked tenderness on palpation between the costal margin and the crest of the ilium on the right side. Roentgenograms showed a triangular density at the base of the right lung extending from the hilum to the diaphragm. A fluid level was noted in the lateral projection beneath the diaphragm, and a bronchogram demonstrated a tract leading through the diaphragm to this fluid level.

The patient was placed on postural drainage and became afebrile five days after admission. Cough and sputum had ceased after one month and he was discharged.

He was readmitted two years later, on August 25, 1928. In the autumn of 1927, he had had severe interscapular pain followed by recurrence of the cough and sputum which had continued for two weeks. At the time of readmission, he complained of recurrence of the interscapular pain and believed that his purulent sputum was about to recur. On the day after readmission, a right subphrenic abscess was drained through a posterior incision. The cavity was found to extend from a diaphragm down to the brim of the pelvis. Postoperative irrigation of the abscess cavity was discontinued because the patient complained that he tasted the irrigating solution. Convalescence was otherwise uneventful and the wound healed rapidly.

**Case 3**—F. M., laborer, age 29, had been treated by the Department of Internal Medicine of the University Hospital for diabetes mellitus from May 26, 1930, until July 21, 1930. Blood Kahn test at that time had been found to be one plus and a history of previous antisyphilitic therapy had been obtained. He was discharged with the diabetes well controlled by dietary measures.

Upon readmission December 27, 1930, the patient complained of cough and pain in the left side of the chest. These symptoms had been present for five days. There was no history of abdominal pain. On examination he was found to be moderately dyspneic. Temperature was 101° F. Flatness to percussion and absent breath sounds were noted below the sixth rib posteriorly on the left. A roentgenogram of the chest showed ob-

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scuration of the left costophrenic angle and the lower half of the left lung field up to the level of the fourth interspace anteriorly with an upward curve in the axilla. On fluoroscopy the left hemidiaphragm was found to be elevated and fixed.

Three days after admission the temperature rose to 103° F, pulse 130, respirations 30. Thoracentesis of the left chest yielded sanguinopurulent material, culture of which subsequently showed a *Streptococcus hemolyticus*. At this time the patient was raising an average of 120 Gm of mucopurulent sputum daily, a stained specimen of which showed relatively few pus cells but many cocci. The patient's general condition seemed to improve somewhat during the next few days.

On January 8, 1931, 13 days after admission, he suddenly coughed up over 100 Gm of extremely foul yellow pus which was similar in appearance to that obtained on thoracentesis ten days previously. Following this incident, the temperature became practically normal. During the next week, the quantity of sputum ranged from 200 to 350 Gm.



FIG 1—(Case 3) Roentgenograms of chest 13 days after rupture of subphrenic abscess into bronchus. (A) Postero-anterior view. Marked elevation of left hemidiaphragm (indicated by upper arrow). Air bubble and fluid level in abscess cavity (lower arrows). (B) Left lateral view. Contour of elevated hemidiaphragm well demonstrated (arrow indicates dome of diaphragm). Air bubble and fluid level in abscess cavity.

On January 18, 1931, the temperature again began to rise and the patient became dyspneic and cyanotic. Roentgenograms of the chest (Figs 1A and B), January 21, 1931, showed a marked elevation of the left hemidiaphragm with an air bubble and fluid level in the abscess cavity.

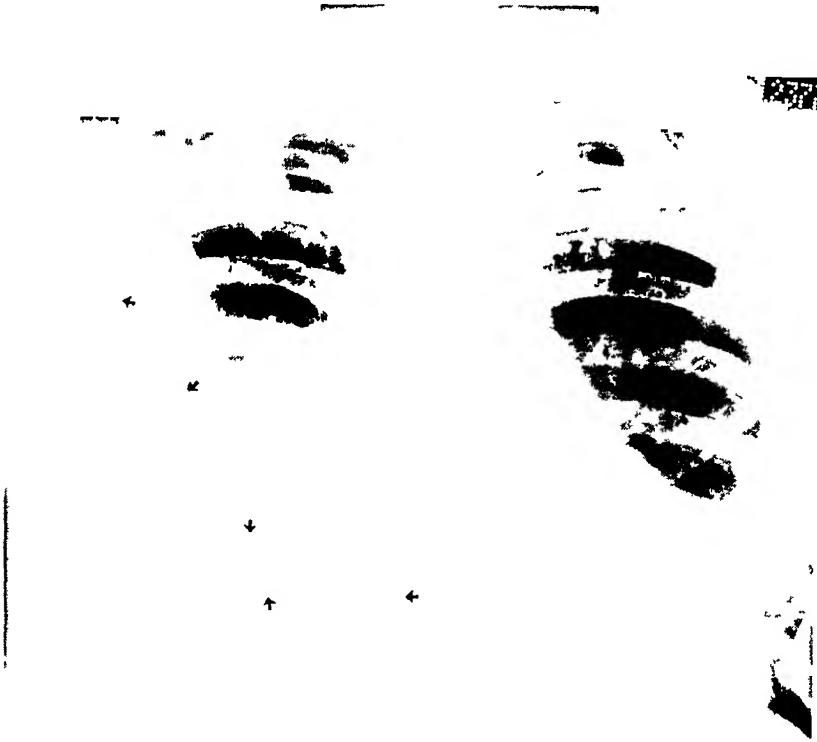
On January 24, 1931, under local anesthesia, a portion of the ninth rib in the posterior axillary line was resected. A large subphrenic abscess was found, the spleen being palpable inferiorly. The abscess cavity was packed with gauze, and a thoracentesis performed in the fourth interspace in the posterior axillary line, and pus was obtained which appeared to be identical with that obtained from the subphrenic abscess. This pus was evidently obtained from an undrained pocket of the abscess.

The immediate postoperative condition of the patient was satisfactory. Eight hours postoperatively symptoms of a severe acidosis were evident. These, however, were adequately controlled by insulin and glucose. Five hours later the patient suddenly died. The cause of death was not determined as permission for autopsy was refused.

Case 4—T M, laborer, age 30, was admitted to the University Hospital November 23, 1933, complaining of abdominal pain of four days' duration. A diagnosis of generalized peritonitis was made and the patient was placed on the Ochsner regimen. The temperature, which had been 102° F upon admission, subsided satisfactorily. On the

tenth day of hospitalization, however, it rose to  $103^{\circ}$  F following a chill. On the fifteenth day, the patient complained of pain beneath the right costal margin.

A roentgenogram of the chest (Fig 2) the next morning demonstrated an air bubble and fluid level beneath the right hemidiaphragm as well as a moderate pleural effusion. That afternoon the patient had a sudden coughing attack and expectorated a large quantity of foul, sanguinopurulent material. He was immediately taken to the operation room and a large right subphrenic abscess was drained through an anterior incision. A small perforation of the diaphragm was noted at operation. Convalescence was stormy.



T.M. 5-8-33

FIG 2—(Case 4) Roentgenogram of chest five hours before rupture of subphrenic abscess into bronchus. Upper arrows indicate upper level of a pleural effusion. Lower arrows indicate dome of diaphragm and fluid level in subphrenic abscess cavity.

A loop of small bowel herniated into the wound on the first postoperative day and was replaced. The patient continued to raise a moderate amount of foul sputum. On the thirty-ninth postoperative day an additional pocket of pus was found anteriorly and drained. Following this procedure, convalescence was uneventful and the sputum became negligible in amount.

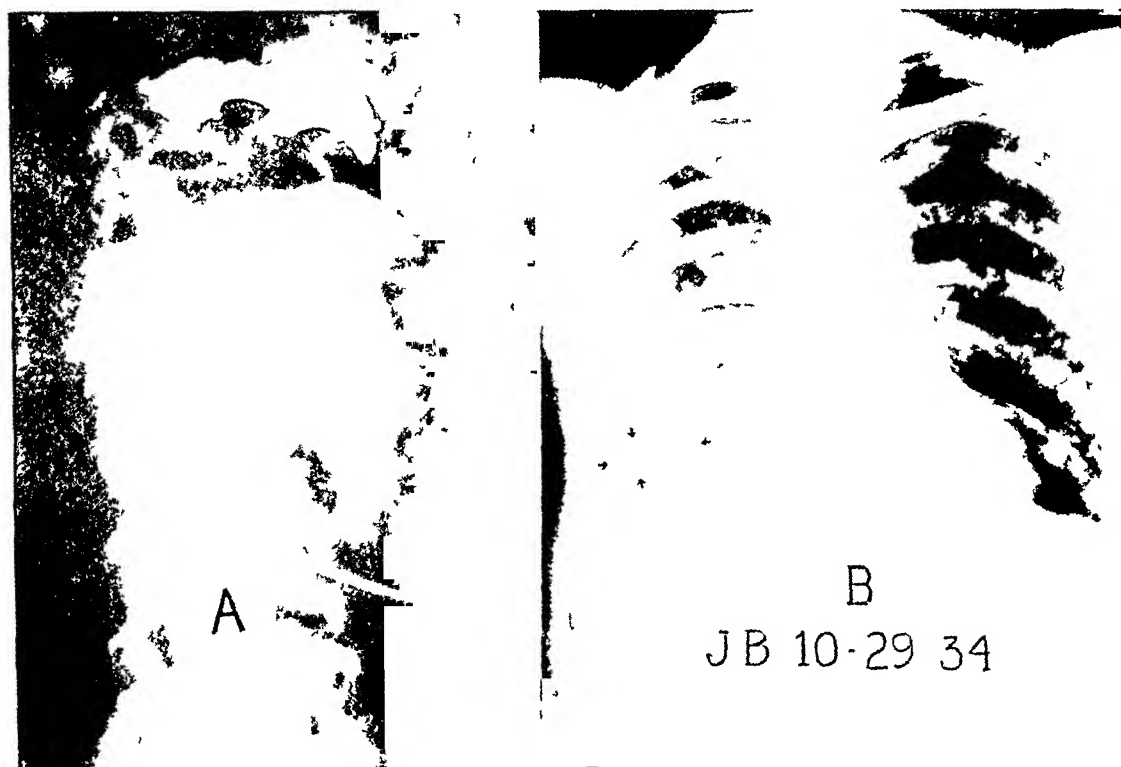
The sinus was still draining in August, 1933. A roentgenogram of the chest showed a considerable amount of pleural thickening at the base of the right lung, but there was no evidence of empyema. An appendicectomy was performed August 7, 1933. Ten days later, the sinus tract was explored and a residual cavity with thickened walls was found above the liver. This was drained through a large, stiff rubber tube. Postoperative irrigation of the cavity resulted in the expectoration of a small amount of mercurochrome.

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which had been used as the irrigating fluid. Convalescence was otherwise uneventful and the wound had practically healed at the time of discharge, January 10, 1934.

**Case 5—J B**, Negro, laborer, age 48, was admitted to the University Hospital October 2, 1934, complaining of two draining abdominal sinuses. Appendicectomy had been performed at another hospital for acute appendicitis six months previously. This wound had never completely healed. A right subphrenic abscess had been drained two months after the appendicectomy and this had also continued to drain.

Examination upon admission revealed extreme emaciation. A fecal fistula was present in the right lower abdominal quadrant at the upper end of a scar. The eleventh rib in the right midaxillary line had been resected and there was a sinus at this site, drainage from which was also fecal in character. Injection of the upper sinus with



**FIG 3—(Case 5)** (A) Right lateral roentgenogram of upper abdomen following injection of iodized oil into inadequately drained subphrenic abscess. Elevated right hemidiaphragm over abscess not shown but normal left hemidiaphragm well demonstrated. Roentgenogram of chest on same date demonstrated no communication with bronchus. (B) Roentgenogram of chest nine days later and one day after rupture of subphrenic abscess into bronchus. Iodized oil previously injected into abscess cavity now distributed throughout both pulmonary fields. Arrows indicate subphrenic abscess cavity.

iodized oil demonstrated a persistent subphrenic abscess (Fig 3A). No oil was seen in the pulmonary fields. A barium enema revealed a fistulous tract between the lateral margin of the right colon and the draining sinus in the right lower quadrant.

On October 23, 1934, the right posterior subphrenic space was explored after resection of the twelfth rib. No pus or oil was found. On the fifth postoperative day, the patient had repeated hemoptyses followed by the expectoration of a large amount of foul sputum. A roentgenogram on the following day (Fig 3B) showed a small residue of iodized oil with a fluid level and air bubble beneath the right hemidiaphragm, and iodized oil was seen to be distributed throughout both pulmonary fields. Pleuritis and pneumonitis were noted at the base of the right lung.

The right anterior subphrenic space was explored November 1, 1934. Again no abscess was found, but a fecal fistula involving the ascending colon was closed. The patient died five days later of bronchopneumonia.

**Autopsy—**A small subphrenic abscess was found posteriorly. There was a perforation through the right hemidiaphragm which easily admitted a finger. Above the perfora-

ration was a small localized empyema pocket, the pleurae being densely adherent except at this point

Case 6—J G, male, bricklayer, age 43, was admitted to the University Hospital September 6, 1935, complaining of the expectoration of large amounts of purulent sputum. Seven years previously he had developed severe abdominal pain which had subsided without operative intervention. Two weeks after the onset of this pain, he suddenly began to expectorate a large amount of foul, purulent sputum. Two weeks later an abscess was drained through an incision below the twelfth rib in the right posterior axillary line. Drainage from the abscess ceased after a few weeks, but the cough and sputum persisted.

For four years prior to admission the patient had been receiving bronchoscopic aspirations at regular intervals. Autogenous vaccines, prepared from the secretions of the paranasal sinuses, had been administered, and tonsils and teeth had been removed as possible foci of infection. No relief had been obtained from these measures.

Examination upon admission revealed the patient to be in relatively good general condition. There was a right chronic otitis media. Percussion note was impaired and breath sounds were distant at the base of the right lung both anteriorly and posteriorly. Marked hypertrophic osteo-arthritis was present.

During the first week of hospitalization, the temperature ranged from normal to 102° F, with daily elevations to at least 100° F. Sputum was mucopurulent in character and varied from 55 to 350 Gm a day in quantity.

A roentgenogram of the chest revealed chronic pneumonitis in the inferior division of the right posterior lobe and the middle lobe, with obliterative pleuritis in the right axillary region. The right hemidiaphragm was elevated and fixed. A bronchogram showed a localized saccular dilatation of a tertiary bronchus in the anterior portion of the middle lobe. No iodized oil was seen below the level of the diaphragm.

Bronchoscopy, September 12, 1935, revealed that the secretions were draining into the right stem bronchus and were coming chiefly from the right middle lobe orifice.

On September 19, 1935, an exploratory thoracotomy was performed, portions of the fifth and sixth ribs being resected for a distance of 7 cm laterally from the costal cartilages. The pleura was found thickened and the lung adherent. The lung was incised and the pulmonary tissue found to be atelectatic and considerably fibrosed. A fistulous tract was entered at a depth of about 2 cm which, superiorly, communicated with a bronchus. The tract was followed inferiorly and found to enter a small empyema pocket which, in turn, communicated with a subphrenic abscess, extending below the diaphragm for a distance of 10 cm. The opening in the diaphragm was estimated to be about 1 cm in diameter. This was dilated and a large rubber tube inserted for drainage.

The immediate postoperative course was uneventful. By the fourteenth postoperative day the sputum was negligible in amount and the temperature was normal. The broncho-pleurocutaneous fistula resulting from the incision of the sinus tract closed spontaneously in seven weeks. The subphrenic abscess granulated rapidly and was completely obliterated 11 weeks after operation.

The wound, however, remained open due to an osteomyelitis of the stump of the sixth rib. A small portion of this rib was resected October 24, 1935. Because of an extension of this process, 12 cm of the same rib were resected January 15, 1936. The wound became grossly infected following this procedure, although the infection became well localized by the fourteenth postoperative day. Convalescence was thereafter uneventful until one month postoperatively, when the patient suffered a sudden attack of unconsciousness, lasting about one hour. During the next few days, he became increasingly more drowsy and disoriented, finally becoming comatose, and died February 21, 1936.

*Autopsy*—The cause of death was determined to be a brain abscess, located in the left frontal lobe. The right pleural cavity was obliterated by adhesions. All lobes of the right lung showed patchy areas of atelectasis and chronic fibroid pneumonitis. The perforation of the right hemidiaphragm had healed completely. There were many dense

adhesions over the superior aspect of the right lobe of the liver, but no evidence of any residual subphrenic abscess was found

TABLE II  
CASES OF SUBPHRENIC ABSCESS WITH BRONCHIAL FISTULA REPORTED  
IN THE LITERATURE

Author	Year	Total	Mortality Per Cent	Cases with Bronchial Fistula			
				Number	Per Cent of Total	Died	Mortality Per Cent
Cauderay*	1902	—	—	20	—	16	80 0
Barnard*	1908	76	47	4	5 3	?	?
Piquand	1909	890	60	112	16 4	76	67 5
Ross	1911	31	33	1	3 2	1	100 0
Ullman and Levy	1920	—	—	1	—	0	0 0
Dexter	1927	6	33	1	16 6	0	0 0
McNamee	1930	15	33	1	6 6	0	0 0
Schwartz	1930	8	50	1	12 5	1	100 0
Beye	1932	31	39	6	19 3	?	?
Ochsner and Graves	1933	50	32	1	5 0	0	0 0
Overholt and Donchess	1935	25	32	1	4 0	1	100 0
Steele	1936	48	50 8	6	12 5	3	50 0

\* Included in Piquand's series

SUMMARY—(1) Perforation of the diaphragm by a subphrenic abscess with subsequent rupture into a bronchus is a somewhat rare occurrence

(2) The literature on this subject is reviewed and six additional cases are presented

(3) The incidence of this complication rises with delayed diagnosis and treatment

(4) The mortality of 50 per cent in our series of six cases was approximately the same (50 8 per cent) as in our general series of 48 cases of subphrenic abscess

(5) The diagnosis may be difficult to establish

(6) Surgical drainage of the subphrenic abscess is advised as the treatment of choice

In the fourteen months from January 1, 1936, to March 1, 1937, ten additional cases of subphrenic abscess were admitted to the University of Michigan Hospital. Two of these were complicated by bronchial fistula. Both patients are living.

#### REFERENCES

- <sup>1</sup> Barnard, H. L. Surgical Aspects of Subphrenic Abscess. *Brit. Med. Jour.*, 1, 371, 1908.
- <sup>2</sup> Beye, H. L. Thoracic Complications of Subdiaphragmatic Infection. *Jour. Thor. Surg.*, 1, 655, 1932.
- <sup>3</sup> Cauderay, H. Contribution à l'étude des abcès sous-phréniques se terminant par vomique. Thèse de Paris, 1902.
- <sup>4</sup> Dexter, R. Observations on the Diagnosis of Subphrenic Abscess. *Am. J. Med. Sci.*, 170, 810, 1925.
- <sup>5</sup> McNamee, E. P. Subphrenic Abscess. *Am. Jour. Roentgenol.*, 24, 125, 1930.

- <sup>6</sup> Nesbit, R M , and Keene, C H Perinephric Abscess with Bronchial Fistula, A Preliminary Report Univ of Mich Hosp Bull , 2, 19, 1936
- <sup>7</sup> Ochsner, A , and Graves, A M Subphrenic Abscess ANNALS OF SURGERY, 98, 961, 1933
- <sup>8</sup> Overholt, R H , and Donchess, J C Subphrenic Abscess New England Jour Med , 213, 294, 1935
- <sup>9</sup> Piquand, G Les abces sous-phrenique Rev de Chir , 39, 156, 1909
- <sup>10</sup> Ross, G G Subphrenic Abscess the Result of Acute Inflammation of the Vermiform Appendix J A M A , 57, 526, 1911
- <sup>11</sup> Schwartz, J Suppuration in Subphrenic Region with Special Reference to Primary Idiopathic Liver and Subphrenic Abscess Arch Surg , 20, 317, 1930
- <sup>12</sup> Ullman, A , and Levy, C S Subphrenic Abscess Surg , Gynec and Obstet , 31, 594, 1920



## DRAINAGE OF THE ABDOMINAL CAVITY IN OPERATIONS FOR PERFORATED PEPTIC ULCER

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PRESUMABLY, in a discussion of this question, the viewpoint taken ought to be one which offers the best hopes of recovery to the greatest number of patients. Inevitably in the most serious surgical emergencies, conditions surrounding the operation frequently fall far short of the ideal. Many of the operations will be performed by a junior surgeon, and as there are few questions in abdominal surgery requiring greater nicety of decision than that of when, and how, to drain, it would seem on the face of it that it were better to say "when in doubt, drain" rather than "when in doubt, do not drain." There is no unanimity of opinion, however, concerning the advisability of drainage of the abdominal cavity in operations for perforated peptic ulcer.

Many operators never drain because it appears that drainage accomplishes little, stating that adhesions soon form around the drain and in a few hours possibly it drains but a small area. In spite of this it is certain that a wide area of the abdomen is drained. This is especially true in the first few days after operation, when the inflammation is still marked and the voluminous exudate prevents peritoneal adhesions. Adhesions, between structures surrounding the drain, develop only as the inflammation is reduced in severity. At this time also comes the reduction in the area which is affected by the drain.

Many experimentators, Buchbinder, *et al*, have attempted to prove by animal experimentation that a drain will act only for a very few hours in suppurative peritonitis in dogs. This statement I do not think will apply to the peritonitis under discussion. In perforative peptic ulcer the abdomen is filled with a flood of gastric and duodenal digestive substances which in themselves will, and do, tend to prevent the formation of adhesions. Despite the high incidence of positive cultures obtained in these cases, rarely in the first hours do we see even filamentous adhesions but rather excessive cloudy fluid throughout the entire abdomen. When adhesions do form it means that the drain has done its duty and should be removed. It is astonishing the change that follows drainage in these cases. The board like abdomen becomes soft, pliable and insensitive within a few hours.

Donald Guthrie, in 1923, sent out a questionnaire in which surgeons all over the country were asked whether they employed drainage in these cases. One hundred and one replied that they did so in all cases. Five men usually did, and 18 drained only occasionally. There were 13 surgeons who stated

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that they did not employ drainage at all. Although the ensuing 12 years may have brought about some change in opinion, it has not brought agreement, as even a brief perusal of the current literature will show. Series of cases of perforated ulcer form a rather favorite topic for reports. Few are available for this discussion, however, as most authors treat the question of drainage in a rather cursory manner. Our preference is for the routine drainage of these cases, a preference which we cannot support statistically. In the available reports, difference of opinion lies chiefly in the management of the early cases, perforated less than 12 hours before operation. A number of surgeons, ourselves included, favor drainage as a routine in these cases. A second group oppose drainage on theoretic grounds, but in practice drain a large proportion of their cases. A third group employ primary closure in early cases, although they drain the late ones in which there is much soiling. A comparison of the mortality statistics of these three groups seems to argue against the practice of drainage (Table I).

TABLE I  
MORTALITY STATISTICS OF DRAINAGE IN ALL CASES

	Cases	Mortality—Under 12 Hours
Brown, H. P., Philadelphia	100	28.0%
Starbuck, Mt. Sinai, New York City	88	13.0%
Williams and Walsh, England	158	20.0%
Eliason and Ebeling, Philadelphia	74	26.0%
Total	420	21.75%

MORTALITY STATISTICS OF SURGEONS WHO DRAIN FREQUENTLY

	Cases	Mortality—Under 12 Hours
McCreery, Bellevue	25	6%
Corvose, Providence	106	20%
Bryce, Manchester, England	154	10%
Total	285	13%

MORTALITY STATISTICS OF SURGEONS WHO DRAIN ONLY LATE CASES

	Cases	Mortality—Under 12 Hours
Semb, Sweden	166	8.0%
White and Patterson, Roosevelt	79	6.0%
Gibson, New York Hospital	123	12.0%
Gilmour and Saint, England	64	2.0%
Bager, Sweden	88	9.0%
Total	520	7.4%

#### SUMMARY

	Mortality—Under 12 Hours	13-24 Hours
Drain all cases	21.75%	60%
Drain frequently	13.0%	40%
Drain only late cases	7.4%	27%

The problem, however, is not so simple that it can be answered by quoting mortality statistics. Doctor Ebeling and the author collected the data from 70 reporters, totaling 5,061 cases of perforation in this country and abroad, and found the mortality approximately 24 per cent. It was interesting to

note that in these 70 reports the mortalities ranged from zero to as high as 60 per cent. It was also noticed that the zero men reported never over 15 cases, usually under ten. But little could be found concerning drainage.

It is a mistake to compare statistics. As has been stated, statistics are of value only to the man making them. Until all writers use the same language, so to speak, comparisons are inconclusive. One writer's mortality figures are based on the premise that a surgical death must happen in seven days and be directly due to the surgical condition. If the patient dies of pneumonia three weeks later, it is not a surgical death. This diversity of time limit is known to range from 48 hours, entire hospital stay, days, weeks or even months. Two of our cases, for example, died on the thirty-ninth day and the forty-eighth day, respectively.

If only an occasional case might be saved by the institution of drainage, we are in favor of it. It is significant, we believe, that, although there is much talk about drains being unnecessary, there are no definite records of cases in which the insertion of a drain for a few days has done harm. Prolonged abdominal drainage in these cases as elsewhere may favor the development of intestinal obstruction, but prolonged drainage is not required or suggested for perforated ulcer.

Our contention is that after the surgeon has dealt with the perforation itself he must recognize and deal with an infection, actual or imminently threatened. Drainage is fundamental to the treatment of infection. The fact that drainage of the peritoneal cavity cannot be accomplished as effectually as elsewhere, and that the peritoneum itself is astonishingly efficient in combating infection, does not excuse the surgeon from attempting to aid nature.

It is often argued that the contents of the upper gastro-intestinal tract which escape through a perforation are sterile. Careful bacteriologic examinations do not bear this out. Such positive findings as are obtained carry more weight than innumerable negative cultures (Table II).

TABLE II  
BACTERIOLOGIC REPORTS

	Time	Positive
Brutt	Under 12 hours	74%
	Over 12 hours	93%
McCreery	Under 10 hours	50%
Elason and Ebeling	Under 12 hours	80%
Bartle and Harkins	"	79%
Watson	"	81%

Among the organisms reported are *Staphylococcus hemolyticus albus*, *Streptococcus viridans*, nonhemolytic *Streptococcus* and *B. coli communis*.

A further argument for drainage lies in the common cause of death in this condition. It is not intestinal obstruction or any other condition which might be aggravated or precipitated by the use of drainage. It is a condition which conceivably may be helped or prevented by drainage namely, peritonitis. A further peculiar feature about this type of peritonitis is that death occurred in our cases usually in three to four days after operation, whereas

in cases of suppurative peritonitis due to lower bowel perforation, appendicitis, *etc*, death does not ensue, as a rule, until after five to eight days. Table III refers to diffuse peritonitis only. If there are added the deaths due to septic sequelae (subphrenic abscess, pylephlebitis, liver abscess, empyema), the figure will be considerably increased.

TABLE III  
PERCENTAGE OF DEATHS IN CASES OF DIFFUSE PERITONITIS

	Number of Cases	Percentage of Deaths
General peritonitis	398	59.0%
General peritonitis + shock	13	2.0%
General peritonitis + pneumonia	4	
General peritonitis + evisceration	5	
Subdiaphragmatic abscess	33	4.9%
Intestinal obstruction	8	
Cardiac (sepsis?)	31	4.6%
Shock (sepsis?)	29	4.3%
Table (sepsis?)	6	
Pulmonary complications	103	15.3%

As to the type of drainage used, our preference is for drainage of the site of perforation by a soft cigarette drain through a stab puncture at a dependent point and a similar drain laid laterally between the liver and diaphragm if infective material is found there. Fleming recorded subdiaphragmatic abscesses in three cases of upper abdominal drainage. Richardson mentions a similar occurrence. McGlannan and Bongardt also had three deaths from abscesses in this region, and now they drain this area. In addition, in cases with extensive contamination, especially if there is a collection in the pelvis, one of us (E. L. E.) has been impressed with the amount of material which is discharged upon the dressings for several days from a suprapubic drain placed into the pelvis. If the patient does well, and drainage is slight in amount, the drains may be removed in 48 to 72 hours. The circumstances of the case may sometimes call for the use of additional drains in the subphrenic or subhepatic areas. We regard the choice of a particular type of drainage as a matter of individual preference and as distinctly secondary to the main decision as to the employment or nonemployment of drainage of the abdomen.

In our last 18 cases the operative mortality was 11.1 per cent, the incidence of positive culture was 80 per cent. Four of the five positive culture cases recovered, and all but two of the total number of cases were drained, which would compare favorably with the percentages of the nondrainage advocates.

*Comment*—Although collected statistics do not bear us out, we are inclined to think that, other things being equal, similar comparisons, *etc*, drainage of the peritoneum after perforation of a peptic ulcer saves more lives than closure without drainage in the hands of the same surgeon. We have found no evidence to prove that drainage is responsible for the increased mortality published by the advocates of this principle. I do not think we have as yet solved the problem.

# MULTIPLE POLYPOSIS OF THE COLON

## A FAMILIAL DISEASE

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LOCKHART-MUMMERY,<sup>3</sup> in 1934, presented three striking instances of the familial occurrence of "Adenomatosis of the Colon." This disease, occurring in families, is as truly inherited as Friedrich's ataxia or hemophilia, and as Lockhart-Mummery says, "a change, or mutation has taken place in the genes of some individual who has not personally exhibited the diseased condition, but who has passed the mutated genes on to his descendants." Again he states, "When a mutation of the genes has taken place, the results may appear in succeeding generations either as dominants or recessives. If as a dominant the condition will tend to occur in every generation, but if the disease is a recessive it will only be seen when both parents carry the mutative genes which may not occur for very many generations, and then the hereditary factor is very likely to be missed."

Lockhart-Mummery presented three very interesting charts. The families were three in number, two which came under his own observation and one taken from Zahlmann. The three groups may be briefly summarized as follows:

**Case 1 —(L-M)** A woman, who died at 42 of cancer of the rectum, had nine children, of whom seven died of the same condition. One son who developed cancer of the rectum married a healthy woman who bore him three children, of whom two had adenomatosis of the colon. Another son, who also had cancer of the rectum, had four children, of whom two had adenomatosis of the colon, one of whom developed cancer of the rectum, of which he died.

**Case 2 —(L-M)** A man and woman, both of whom developed cancer of the rectum, had ten children, of whom four died of the same disease. One of these four had six children of whom two had adenomatosis of the colon, one of the latter developing cancer of the rectum, from which he subsequently died.

**Case 3 —(Zahlmann)** A man who died of cancer of the rectum had two children, one a male who developed adenomatosis resulting in cancer of the rectum, and subsequent death. By his wife he had four children, all of whom developed adenomatosis of the colon, and one of these had cancer of the rectum and died. This same wife had, by another husband, two healthy children who never developed the disease.

Hullsick,<sup>2</sup> in 1928, collected from the literature 127 cases of polyposis of the colon, of whom 46 (36 per cent) developed cancer and of whom 11 per cent showed a positive familial history. He reported an instance of two brothers with polyposis, sons of a father who died of "bowel trouble." He referred to Duke's three cases, in all of which there was a striking example of familial occurrence of cancer or polyposis of the colon or rectum. Barker<sup>1</sup>

in 1930, emphasized the familial occurrence of polyposis and spoke of it also as a precancerous condition. He had a male patient with polyposis of the colon, in whose family he found, with the same disease, a grandmother, great grandfather, and among the aunts and uncles (and great aunts and uncles), eight more cases, 11 in four generations of the same family.

Rankin,<sup>4</sup> in 1935, read a report, supplementary to a previous one in 1931, presenting three more cases of polyposis. One was a girl of 19 with no significant family history, the second a woman of 32 with polyposis, whose mother had died at 32 of the same disease, and the third a woman of 28, who had a brother and sister suffering from the same condition.

Inasmuch, therefore, as polyposis of the colon may thus be a familial disease, and is a definitely precancerous lesion, we may say that in this one condition, at least, we have positive evidence of the rôle that may be played by heredity in the development of cancer. In order to emphasize the familial aspect of the disease, as a matter of biologic interest, the following two case reports are cited.

**Case 1**—Male, age 32, police officer. Two brothers living and well, one sister living (Case 2).

Family history negative except that father died of some wasting disease which caused him to go repeatedly to the toilet and pass small bloody movements (one might reasonably consider this to have been cancer of the rectum). Previous history not significant.

He entered the Massachusetts General Hospital December 27, 1932, with a history of frequent, soft bowel movements, with an excessive amount of flatus.

Proctoscopy showed multiple polyps of the rectum and lower sigmoid, and also a definite carcinoma of the rectum, which biopsy proved to be an adenocarcinoma Grade 2.

*Roentgenologic Examination*—"There is definite delay in the passage of barium through the rectosigmoid, which is narrowed and definitely irregular. The irregularity is apparently produced by numerous polypoid masses. The narrowing may be due to these polypoid defects, but there appears to be an organic constriction also. In addition to the polypoid filling defects in the rectosigmoid, similar defects are seen in the entire descending colon, sigmoid and rectum. Smaller and less distinct filling defects are seen in the transverse colon. No definite polyps are demonstrated in the cecum."

*Operation*—January 7, 1933. Combined abdominoperineal resection of sigmoid and rectum. An artificial anus was made by pulling out the lower end of the upper sigmoid segment through a stab wound in the left side of the abdomen. Convalescence from this operation was uneventful and the patient was discharged February 8, 1933.

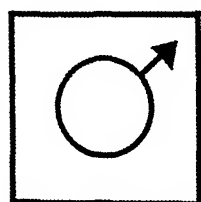
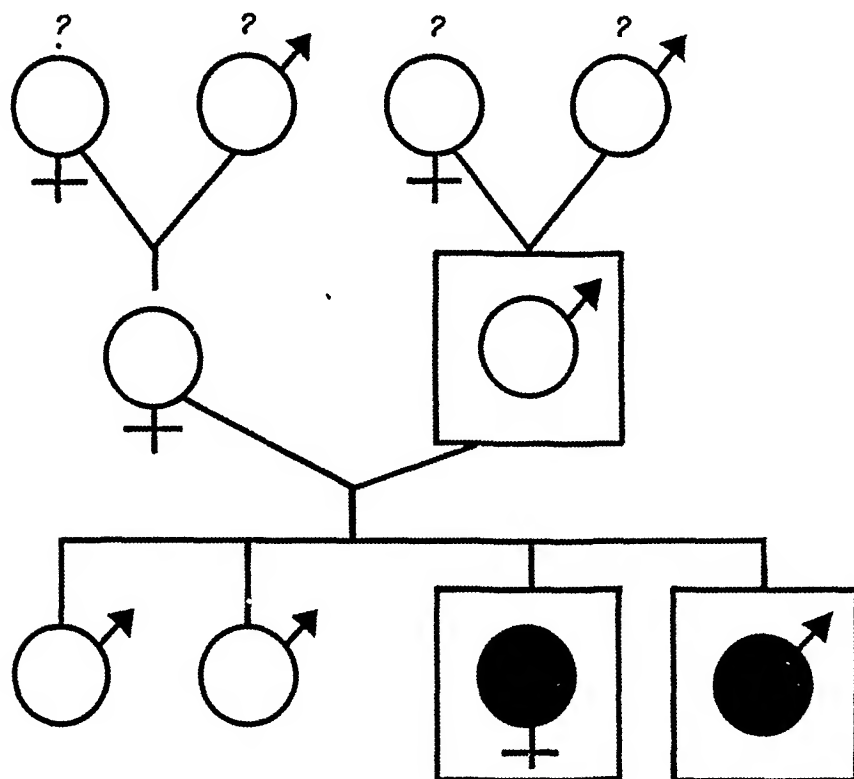
*Pathologic Report*—"Fifty-two cm of large bowel with rectum and anus and underlying mesentery. Fifteen cm from the anus is a constricting ulcerated mass 6 cm in length. The edges of this mass are elevated about 4 mm. On section this mass extends throughout the wall. Scattered on the mucosal surface of the remaining portion of the bowel are found numerous pedunculated reddish cauliflower-like polyps, the largest of which measures 3 cm in diameter and is located 2 cm from the large tumor mass. Several of the other polyps show ulcerated surfaces. The polyps extend to the extreme margin of the resection. Several involved nodes are found in the mesenteric fat." *Diagnosis* "Adenocarcinoma Grade 2, with metastases to the regional nodes. Polyposis coli."

As it was realized that the patient had numerous other polyps, he was advised to have the remainder of his colon removed. He returned to the hospital April 11, 1933, for this procedure. The remaining colon, with a short segment of terminal ileum, was removed, and an ileostomy performed.

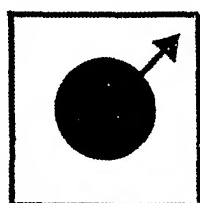
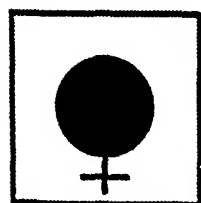
*Pathologic Report* of second specimen—"Four cm of terminal small bowel and 104

cm of large bowel. The serosal surface is smooth. The mucosa is sprinkled with small polypi, some of which are pedunculated. The largest polyp measures 0.7 cm in diameter. There is an even distribution of polypi in all portions except the cecum which contains relatively few. The polyps are all soft and none of them appear to be invasive at their bases. There is no apparent injection or ulceration of the remaining mucosa.

He left the hospital in good condition and, in spite of his ileostomy, continues his duties.



CANCER OF RECTUM WITHOUT HISTORY OF POLYPOSIS



CANCER OF RECTUM OR COLON  
COMPLICATING POLYPOSIS

CHART 1—Showing the pedigree of the two cases cited of familial polyposis of the colon

as a policeman. His only complaint is occasional tightening of the skin and superficial tissues around the ileostomy opening, with consequent interference with free emptying of the bowel.

**Case 2**—Female, aged 23, sister of Case 1. First seen June 30, 1930 when she complained of having had moderate diarrhea, with occasional blood for eight years. For the

\* This case was under the care of one of us (R. H. S.) and Dr. Daniel F. Jones, to whom we are indebted for permission to report it.

condition she had two operations performed, an appendicectomy, and later a clamp and cautery procedure for hemorrhoids

*Proctoscopic Examination*—July 1, 1930 "The whole rectum was found to be covered with polyps from one-eighth to one inch long. Some were sessile and some pedunculated. One suspicious appearing lesion was in part removed for examination." This proved to be a malignant adenoma, Grade 3.

*Operation*—July 10, 1930. A combined abdominoperineal removal of the sigmoid and rectum was performed. A definite carcinoma was found in the sigmoid (besides the one in the rectum). The pathologic report was "adenocarcinoma Grade 1, with hyperplasia of contiguous lymph nodes." The patient left the hospital in good condition August 24, 1930.

One month later she returned, and on October 11, 1930, the remaining colon was removed and a permanent ileostomy effected. It is interesting that there were absolutely no adhesions from the preceding operation. The pathologic report showed besides the polyps, another area of cancer, the third to be found. "The specimen consists of two pieces of large intestine, cecum and terminal ileum, measuring 71 and 36 cm. respectively, and also 6 cm. of ileum. Serosal surface negative. Entire mucosa of colon has adherent, numerous, soft, reddish, pedunculated polypoid masses varying from 0.5 to 4 cm. in diameter, the smaller ones are more proximal, the larger ones more distal. In the lower portion of the colon, 8 cm. from the distal end, is a somewhat firmer flattened polypoid mass 3 x 5 cm. in dimensions. Section shows pale gray tissue somewhat fixed to the muscle. Several small polyps around ileocecal valve and three small ones, 0.5 cm. in diameter, adherent to mucosa of ileum." *Microscopic Diagnosis*. Adenocarcinoma, Grade 1. Multiple mucous and adenomatous polyps.

The patient did fairly well until, on July 2, 1931, an operation became necessary for acute intestinal obstruction. This procedure revealed three interesting findings. First, an almost entire absence of adhesions, second, a still functioning omentum, and third, a volvulus of the terminal ileum. The volvulus was untwisted and a temporary tube ileostomy effected, following which she recovered without untoward event.

It took more than a year for the posterior wound to heal.

In November, 1932, another operation was performed for the removal of a tumor nearly the size of a hen's egg at the lower end of the left abdominal scar. This was naturally thought to be a local recurrence of the cancer. The examination revealed, however, that the "Specimen consists of a piece of tissue 5 x 7 x 4 cm. covered on one surface by a piece of skin. The skin contains a linear scar 6 cm. long. On opposite side of tumor is a portion of striated muscle. On section the tumor mass is rounded, apparently encapsulated, measures 3 cm. in diameter. Semifirm in consistency, and not attached to skin or underlying muscle. Cut surface pink, moist, and bulging. One linear area extending from margin across two-thirds of tumor mass is white and firmer than surrounding tumor tissue." *Microscopic Diagnosis*. Fibrosarcoma, desmoid type.

These two patients, brother and sister, are now comparatively well and free from any evidence of recurrence of cancer. Each presented a not uncommon postoperative complication of this type of radical surgery, namely, one had recurrent trouble from the scar tightening and constricting the ileostomy opening (Rankin mentions this also), and the other developed acute intestinal obstruction. One had a later desmoid tumor in the scar. This patient, the woman, had three definite and unconnected areas of cancer—one in the rectum and two in the sigmoid.

Rankin discusses the procedure, which he has followed successfully in one case, of retaining the lower sigmoid and rectum, after removal of the rest of the colon, destroying the polyps by fulguration, and later performing an ileosig-



moidostomy, thus obviating the necessity of a permanent artificial anus. In the absence of any suspicious malignant degeneration in the segment left in, such a course is certainly worthy of serious consideration.

#### CONCLUSIONS

(1) Multiple polyposis of the colon and rectum may be, and often is, a familial disease. In the study of any such case the family history should be carefully elicited.

(2) These polyps show a notable tendency to become malignant, and in this group of cases there is, indirectly, a definite familial occurrence of cancer in a circumscribed portion of the gastro-intestinal tract.

(3) Multiple polyposis of the colon and rectum is most safely treated by complete removal of the lower intestinal tube, from the terminal ileum to the anus.

(4) If the rectum and sigmoid have been removed for polyposis and cancer, and it is known that there are polyps in the remaining colon, the situation must be explained to the patient, and further radical removal must be urged.

#### REFERENCES

- <sup>1</sup> Barker, L. F. Polyposis of the Colon. Discussion of the Heredo-Familial Occurrence of the Disease and of the Extraordinarily Favorable Effects Obtained in One Case by Deep X-ray Therapy. *Med Clin N Amer*, 14, 77, July, 1930.
- <sup>2</sup> Hullsick, H. E. Multiple Polyposis of the Colon. *Surg, Gynec and Obstet*, 47, 346, September, 1928.
- <sup>3</sup> Lockhart-Mummery, J. P. The Causation and Treatment of Multiple Adenomatosis of the Colon. *ANNALS OF SURGERY*, 99, 178, January, 1934.
- <sup>4</sup> Rankin, F. W. Colectomy for Adenomatosis and Pseudopolyposis. *ANNALS OF SURGERY*, 102, 707, October, 1935.
- <sup>5</sup> McKittrick, L. S., and Miller, R. H. Idiopathic Ulcerative Colitis. *ANNALS OF SURGERY*, 102, 656, October, 1935.

## THE EVALUATION OF ABDOMINAL SYMPTOMS IN THE DIABETIC<sup>†</sup>

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THE proper evaluation of abdominal symptoms in a diabetic often presents a very puzzling problem. In this presentation we wish to discuss some observations made in a study of 1,260 consecutive admissions to the Diabetic Service, which indicate certain basic differences in the degree of severity of abdominal symptoms in diabetic acidosis and in acute abdominal conditions as they occur in the diabetic and nondiabetic patient.

It is of great importance for the surgeon to recognize and appreciate the symptoms of diabetic acidosis. Unfortunately, the terms diabetic acidosis and diabetic coma are linked together in the minds of many physicians and as a result, the symptoms expected in a case of acidosis are deep sighing respiration—increasing drowsiness merging eventually into deep coma. We feel, however, that these are terminal symptoms and there are other and more common symptoms which should be recognized and which are responsible for a surgeon being called in to see these patients. We refer to the abdominal symptoms, namely, nausea, vomiting and abdominal pain and tenderness which are usually associated with fever and leukocytosis. These are present in the vast majority of cases of acidosis before the comatose symptoms develop. In some patients they may be very severe and are responsible for the patient seeking medical attention.

The association of abdominal symptoms with diabetic acidosis had not been pointed out with sufficient clarity until relatively recently. Joslin,<sup>1</sup> F. N. Allan,<sup>2</sup> Joslin, Root and White,<sup>3</sup> and F. H. Allen<sup>4</sup> in recent articles pointed out this association. McKittick<sup>5</sup> and Beardwood<sup>6</sup> emphasize the importance of these symptoms as early indications of the development of diabetic acidosis. The same group of symptoms and clinical findings is also characteristic of an acute abdominal condition and without a careful history, urinalysis, blood sugar, and plasma CO<sub>2</sub> determination, a differential diagnosis of these conditions may be impossible.

It is well to remember that diabetic acidosis seldom comes on suddenly, but usually develops over a period of 24 or 48 hours. The early symptoms are usually polyuria and polydipsia, but these may not be of sufficient severity to have attracted the attention of the patient. The acidosis usually develops rather gradually, but the abdominal symptoms may be of sudden onset.

In this series of 1,260 cases of diabetes there were 136 or 10.8 per cent cases of diabetic acidosis. Ninety-six or 74 per cent of the 136 cases showed, as the predominating symptoms, either nausea, vomiting or abdominal pain,

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<sup>†</sup> Read before the Philadelphia Academy of Surgery, March 2, 1936. Submitted for publication July 25, 1936.

whereas 40 or 26 per cent showed the central nervous system symptoms of drowsiness and coma. In those cases with abdominal symptoms, 85 per cent showed leukocytosis (white blood cells over 11,000) and 80 per cent had a fever (over 99° F). The highest leukocyte count was 44,000 and the highest temperature was 104° F (Table I).

TABLE I  
CASES IN WHICH THERE WERE LEUKOCYTOSIS AND FEVER

	Cases with Abdominal Symptoms		Cases without Abdominal Symptoms		Total of Series	
	Num- ber	Per Cent	Num- ber	Per Cent	Num- ber	Per Cent
Leukocytosis	82	85	23	58	105	89
Fever	77	80	16	40	93	68
Total cases in group	96		40		136	

The clinical appearance of patients suffering from diabetic acidosis is frequently not unlike that of acute intestinal obstruction in that they are toxic, markedly dehydrated, have abdominal distension, pain, nausea, vomiting and obstipation.

**Case 1**—Miss W. S., age 44, was known to have had mild diabetes for some years and was rather careless in her control of the disease. The history revealed that this patient had been vomiting and suffering from obstipation for three days before admission to the hospital. A vague abdominal symptoms had been present for 24 hours, and 12 hours before admission a sudden severe pain developed in the upper right quadrant of the abdomen. Temperature, 103° F. Leukocyte count, 31,000. The diagnosis on admission to the hospital was acute intestinal obstruction. On physical examination, the patient was markedly dehydrated, had some tenderness and rigidity in the upper right quadrant of the abdomen. Urinalysis showed glycosuria, the blood sugar was 420 mg per 100 cc and the CO<sub>2</sub> was 17 volumes per cent. A diagnosis of diabetic acidosis was made and under proper management for this condition, the abdominal symptoms rapidly improved and six hours after admission the abdominal examination was negative and the nausea and vomiting had entirely disappeared.

**Case 2**—A boy, age 13, was not known to have had diabetes. He developed a severe sharp pain in the lower right quadrant of the abdomen accompanied by nausea and vomiting. Temperature, 103.2° F. Leukocyte count, 29,000. He was sent to the hospital with a diagnosis of acute appendicitis. This diagnosis seemed justified in view of the symptoms. A preoperative urinalysis showed glycosuria. Blood studies revealed a blood sugar of 730 mg per 100 cc and a CO<sub>2</sub> of 15 volumes per cent. A more careful history was then obtained and it was learned that the child had been passing large quantities of urine and drinking large amounts of water for seven to ten days before admission. A diagnosis of diabetic acidosis was made and here again under proper treatment of this condition the fever, leukocytosis and abdominal symptoms entirely disappeared.

These two cases demonstrate the importance of a preoperative urinalysis whether the patient is or is not a known diabetic. This procedure is all the more important because of the increasing number of diabetics.

It is an accepted surgical dictum that no major surgical procedure should be performed upon a patient with impending or frank diabetic acidosis. The proper procedure is to treat the acidosis which can usually be controlled suf-

ficiently in three to six hours to permit of a diagnosis of any underlying abdominal pathology which might be present. If an acute abdominal condition is found, surgical intervention should not be undertaken until the acidosis is controlled as there are few cases in which the delay necessary to control the acidosis would increase the operative risk as much as it is increased by operating in the presence of this complication. Operations can be undertaken with a fair degree of safety with a blood sugar two or three times normal, provided the  $\text{CO}_2$  is not below 40 volumes per cent, and we feel that no attempt should be made to lower the blood sugar below 150 mg per 100 cc of blood, immediately before operation. In our opinion, no surgery should be performed with a  $\text{CO}_2$  of less than 40 volumes per cent, and if the emergency will permit, the  $\text{CO}_2$  should be elevated to 45 or 55 volumes per cent.

The danger of operation upon a patient in the presence of diabetic acidosis is illustrated by the following case.

**Case Report**—W. S., male, age 72, had had mild diabetes for some years. It was so mild that neither the patient nor his physician made any effort to control the glycosuria. He had suffered from abdominal pain and constipation for three days prior to admission to the hospital. The pain increased in severity and he began to vomit 24 hours before admission. The patient entered the hospital late at night and the history of diabetes was not obtained at that time. The patient seemed so ill, the abdomen was so greatly distended, and the clinical picture was so typical of intestinal obstruction that operation was performed at once. No obstruction was found at the operation. The blood sugar the following morning was 373 mg and  $\text{CO}_2$  was 12 volumes per cent, and in spite of intensive treatment the patient died six hours later of diabetic acidosis.

There is no satisfactory explanation for the abdominal symptoms in diabetic acidosis. The patients were studied for lesions of the gastro-intestinal and genito-urinary tracts after recovery from the acidosis and no conclusive evidence was found which would explain the abdominal symptoms. Nielsen,<sup>7</sup> Peters,<sup>8</sup> Lawrence, Lucas and McCance<sup>9</sup> and John<sup>10</sup> have all studied the cause of the leukocytosis in acidosis and have advanced ideas relative to the cause of its development. In our cases there was no direct relationship between the presence or degree of severity of the abdominal symptoms and the severity of the acidosis, the age or sex of the patient, the height of the blood sugar or the duration of the disease.

In the series of 1,260 cases, there were 18 patients who had acute abdominal conditions and were operated upon (Table II). It will be noted that although these patients had acute abdominal conditions, the fever and leukocytosis were not very marked and none had acidosis.

The abdominal symptoms in these patients were not nearly so severe as those seen under similar conditions in the nondiabetic. This decreased severity in abdominal symptoms in the diabetic has become more apparent the more cases we see. The number of cases is small, however, the behavior of the patients has been so similar that we feel justified in suggesting that an acute abdominal condition occurring in a diabetic will give symptoms which are much milder than those produced by a similar lesion in a nondiabetic and very much milder than those produced by acidosis alone. The appended case report exemplifies this.

## ABDOMINAL SYMPTOMS IN THE DIABETIC

TABLE II

EIGHTEEN CASES OF ACUTE ABDOMINAL CONDITIONS OCCURRING IN A SERIES OF 1,260  
CONSECUTIVE PATIENTS ADMITTED BECAUSE OF DIABETES

Name	Age	Condition	Blood Sugar, Mg	Plasma Carbon Dioxide	White Blood Cells	Fever
M K	64	Pyelonephritis	210	54	11,000	100°
W H S	62	Gangrene of gallbladder	450	42	17,500	99 4°
A O	54	Ruptured appendix	280	43	14,200	102°
M S	42	Acute cholecystitis	242	50	15,200	100°
J D K	52	Appendiceal abscess	303	54	13,000	99°
M W B	47	Pyelonephritis	250	42	10,500	103°
E T	51	Acute cholecystitis	214	56	11,500	99°
R S	46	Empyema, gallbladder	195	58	13,500	101°
M T F	49	Ruptured appendix	250	44	17,500	102°
P T W	46	Pelvic abscess	243	42	16,250	103°
M B S	59	Empyema, gallbladder	190	40	10,250	99°
R S	14	Acute appendicitis	204	49	10,750	99°
M B	15	Acute appendicitis	195	43	13,700	100°
J S	9	Ruptured appendix	330	44	13,500	102°
T S	43	Diverticulitis with abscess	190	54	11,200	100°
E H	41	Empyema of gallbladder	210	49	12,250	101°
A B	63	Gangrene of gallbladder	181	X	4,800	98°
A W	67	Empyema of gallbladder	196	X	26,800	100°

X—No acetoneuria

**Case Report**—J K, age 52, had been a diabetic for eight years. He developed a rather mild pain in the lower right quadrant of the abdomen and with it had very slight tenderness, no rigidity and a temperature not exceeding 99° F. The patient was observed for several days feeling that he might possibly have a mild case of epidemic gastroenteritis. On the fourth day without any increase in symptoms a mass was felt in the lower right abdomen. He was admitted to the hospital with a temperature of 99° F, a leukocytosis of 13,000, blood sugar, 303 mg, plasma CO<sub>2</sub> 54. He was operated upon and a large appendiceal abscess was found. Here in spite of a large amount of pus, no acidosis had developed and the symptoms were so mild that the extent of the lesion was not recognized.

Acidosis was not present in any of the 18 cases, although most of them had marked infections and even free pus in the peritoneal cavity which had been present for some time before admission. This is not the story of infection elsewhere in the body in the diabetic. Infection nullifies the action of a certain amount of the endogenous and exogenous insulin and usually makes the diabetes more severe and may even be the cause of precipitating acidosis.

In a series of 250 operations performed upon diabetics reported by the authors in 1933, we noted 24 cases that had acute infections within the abdominal cavity and in none of these was acidosis present. However, acidosis did develop in several other cases with relatively mild infections situated elsewhere in the body such as small carbuncles and minor infections of the extremities.

## CONCLUSIONS

- (1) Ninety-six or 74 per cent of 136 cases of diabetic acidosis presented the abdominal symptoms of nausea, vomiting and abdominal pain, which are associated usually with leukocytosis and fever.

- (2) Acidosis should be ruled out in any diabetic presenting abdominal symptoms before surgical intervention is undertaken
- (3) Acute abdominal conditions occurring in diabetics do not seem to produce as severe abdominal symptoms as the underlying pathology would indicate or as developed in a nondiabetic under similar conditions
- (4) Surgery should not be undertaken with a  $\text{CO}_2$  of less than 40 volumes per cent, and if the emergency will permit, the  $\text{CO}_2$  should be elevated to 45 or 55 volumes per cent

## REFERENCES

- <sup>1</sup> Joslin, E P Treatment of Diabetes, Philadelphia, Lea & Febiger, 1928, pp 649
- <sup>2</sup> Allan, F N Am Jour Med Sci, 174, 506, October, 1927
- <sup>3</sup> Joslin, E P, Root, H F, and White, Priscilla Med Clin N Amer, 10, 1024, March, 1927
- <sup>4</sup> Allen F H Encyclopedia of Medicine, Philadelphia, F A Davis Company, 1931, p 516
- <sup>5</sup> McKittrick, L S New Eng Jour Med, 209, August, 1933
- <sup>6</sup> Beardwood, J T, Jr J A M A, 105, pp 1168, October 12, 1935
- <sup>7</sup> Nielsen, O J Ugesk f laeger, 91, 1069 November 28, 1929
- <sup>8</sup> Peters, J P Cited by Lande, Herman The Uncontrollable Causes of Death in Diabetic Coma, J A M A, 101, 9, July 1, 1933
- <sup>9</sup> Lawrence, R D, Lucas, H A, and McCance, R A Brit Med Jour, 2, 145, July 23 1933
- <sup>10</sup> John, H J Am Jour Digest, Diet, & Nutrition, 1, 569, October, 1934

DISCUSSION —Dr F A Bothe in commenting on the tabulated statistics, referred to the last two cases listed in Table II, namely, the patients suffering from acute gangrenous cholecystitis and empyema of the gallbladder illustrate very definitely the experience we have had. These women were both admitted to the hospital with a history of having mild symptoms of seven to ten days' duration. The pain at no time was severe and upon abdominal examination mild tenderness accompanied by marked rigidity was found over the upper right quadrant. In both patients urinalysis revealed glycosuria and no acetoneuria but a definite hyperglycemia was present. In the absence of acidosis in either case, operation was not delayed.

In contrast to these cases, he reported the case of a patient, age 43, who gave a history of having had excruciating abdominal pain and nausea and vomiting of three days' duration accompanied by constipation. She was greatly dehydrated and the abdomen was markedly distended. The temperature was  $103^{\circ}\text{F}$  and the leukocyte count 33,000. She was admitted to the hospital with the diagnosis of acute intestinal obstruction. Knowing that she was a diabetic, he immediately had an urinalysis, blood sugar, and  $\text{CO}_2$  determination made. The urine was strongly positive for sugar, and the  $\text{CO}_2$  was 17 volumes per cent, the blood sugar was 670 mg per 100 cc. A diagnosis of diabetic acidosis was made which definitely contraindicated surgical intervention. Doctor Beardwood treated the patient for the diabetic acidosis and in 12 hours the abdominal symptoms had disappeared, and the patient progressed to an uneventful recovery. After the acidosis had been controlled there were no physical findings on abdominal examination which would point toward any intra-abdominal pathology. The contrast in the symptomatology and laboratory studies in the above cases is most instructive and the more diabetics we see with abdominal conditions the more convinced we are that the symptoms in the diabetic are less severe than in the nondiabetic with intra-abdominal lesions under equal conditions, and that the most severe abdominal symptoms which we find in the diabetic occur in diabetic acidosis.

# SARCOMA OF THE KIDNEY IN ADULTS

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SARCOMA of the kidney in adults is a rare lesion. Ninety-three such tumors form the basis of this communication. Nine were found among the records of the Massachusetts General Hospital, two from the private cases of Dr. George Gilbert Smith and the remainder from the literature.

Kilbane and Lester<sup>1</sup> recently collected 15 cases and added one of their own. Only seven of these are included in this report. Seven were omitted because they occurred previous to 1910. The eighth proved to be a calculous pyelonephrosis. The large series of adult sarcomata reported by Judd<sup>20</sup> and the group of spindle cell sarcomata tabulated by Krietschmer and Randolph<sup>32</sup> are herein included. A complete survey of the literature on this subject has been made and all questionable cases have been omitted. It was quite obvious that certain requirements should be definitely decided upon as to whether a case should or should not be included. Accordingly no case was accepted unless the microscopic report of the tissue examined was so worded that no doubt could be entertained that it fell into this group of kidney tumors. It was for this reason that this series started from 1910. It was not uncommon previous to that time to classify renal cancers as sarcomata. Only those cases of round cell sarcomata were acceptable where it was proven beyond a reasonable doubt (autopsy) that the renal lesion was not part of a generalized blood dyscrasia or an anaplastic carcinoma. It is true that in a number of instances this differentiation proved difficult. When this occurred the case was omitted.

It was equally necessary to omit neoplastic lesions originating in the surrounding mesothelial tissue which secondarily invaded the renal parenchyma. Unless the case history definitely stated that the sarcoma originated in the kidney substance it was omitted. This naturally excluded the retroperitoneal tumors (sarcomata and lymphoblastomata), the neurogangliomata, the sarcomata of the renal capsule, the neuroblastomata and other adrenal tumors.

Although many articles have been written on adult sarcoma, yet no author seems to have drawn the line as to when a renal sarcoma may be called an adult renal sarcoma. With this in mind all cases of renal sarcoma under 21 years of age were excluded.

In many reported series of kidney tumors (Nichols and Shiflet,<sup>18</sup> Neff,<sup>17</sup> Mackenzie,<sup>16</sup> Fedoroff,<sup>15</sup> Phillips,<sup>11</sup> Hyman,<sup>27, 28</sup> and others) mention is made of a case or cases of adult renal sarcoma but no data are given on the particular patient. These likewise had to be omitted from this paper.

*Age*—Age was not stated in 21 instances. Forty, or 55 per cent, oc-

curred between 40 and 60 years Twenty-three, or 33 per cent, were under 40, while only nine, or 12 per cent, were in the sixth and seventh decade (Table I)

TABLE I  
AGE INCIDENCE

Age	Number	Percentage
21-30	8	33
31-40	15	
41-50	23	
51-60	17	55
61-70	5	
71-80	4	12
No mention	21	
Total	93	

*Sex* —The sexes were equally divided, 46 in each It was not noted in one instance (Table II)

TABLE II  
SEX INCIDENCE

Sex	Number
Male	46
Female	46
Not noted	1
Total	93

*Side* —Curiously enough both sides were affected the same number of times, 42 each Bilateral involvement occurred once, and in eight cases the side of the lesion was not stated (Table III)

TABLE III  
SIDE INVOLVED

Side	Number
Right	42
Left	42
Bilateral	1
Not noted	8
Total	93

*Pathology* —The histopathology of these tumors is quite varied, and for all practical purposes, of little help They all seem to be equally effective in producing the same end-result, that is death The nomenclature is surely not without reproach The most that can be said for it is that it confuses the



picture Twenty different names are listed under which this adult sarcoma is masquerading It is conceivable that if more microscopic sections were taken from different parts of the above listed tumors, many would be reclassified and called mixed tumors It would be less confusing to call sarcomata, where two or more different types of cells predominate, mixed cell sarcomata, and reserve separate categories for sarcomata where only one type of cell predominates, such as fibro-, spindle cell, and leiomyosarcomata A division of this sort would by no means be ideal but it would at least have the advantage of simplifying the confused nomenclature

In this series there were 23 spindle cell sarcomata, 12 fibrosarcomata, 16 sarcomata six leiomyosarcomata, four mixed cell, two Wilms' tumor, 11 embryonal mixed tumor, two embryonal myosarcomata, and one each of embryonal adenocarcinoma, embryonal adenosarcoma, lipoleiomyosarcoma, lipomyosarcoma liposarcoma, fibromyxosarcoma, myosarcoma, rhabdomyosarcoma reticular cell sarcoma, round cell sarcoma, teratoma, and osteoblastoma

Bilateral sarcoma occurred once As far as could be ascertained, these were distinct and separate tumors and not extensions Two different types of tumor in the same kidney were noted five times a fibrosarcoma together with an adrenal carcinoma, a fibrosarcoma associated with a papillary carcinoma, a leiomyosarcoma with an adrenal cell sarcoma, a spindle cell sarcoma with a squamous cell carcinoma of the renal pelvis, and an adenocarcinoma with a fibrosarcoma

The association of stones with adult sarcoma occurred three times

Scant data were obtained relative to metastases The information gathered showed that this type of tumor differed little from adenocarcinoma or hypernephroma in the organs attacked Invasion of the renal pedicle, extension to the diaphragm, metastases to the liver, lung and peritoneum were frequent in the cases that came to necropsy

*Symptomatology*—The symptomatology was not unlike that accompanying other types of adult cortical tumors Tumor (mass) is not as predominant a symptom as in sarcoma in children The triad of hematuria, tumor and pain are the chief complaints Gastro-intestinal symptoms, such as nausea, vomiting, eructations, and constipation, appear to be slightly more frequent than in other forms of renal neoplasm Varicocele occurred once as a chief complaint Anemia, loss of weight, lassitude, and edema of legs were noted many times

No statistics are available on the duration of the symptoms Fortunately this knowledge would serve no purpose, as nearly all of the patients died regardless of the duration of symptoms

As Table IV shows, 78 patients were submitted to a nephrectomy An exploratory laparotomy was performed five times Once a partial nephrectomy was performed (Berly<sup>1,4</sup>) and the patient died after the operation Five patients were considered inoperable and in three cases no mention of

the operative procedure was made. A loin incision was made once, but further information in this case is lacking.

TABLE IV

RÉSUMÉ OF OPERATIVE PROCEDURES EMPLOYED IN 93 CASES OF SARCOMA OF THE KIDNEY, AND THE END-RESULTS

Operation	No	No Follow Up	Died	Recurrence	Living Years	Less Than Months	1 Year
Nephrectomy (1 partial)	78	23	30 { 28 within 1 year 2 { 8 years 6 years	4 { 8 months 1 yr 7 mos No time ? recurrence (3 yrs)	21 { 20 yrs 2 yrs 3 mos 6 yrs 3 mos 7 yrs 1 yr 3 mos 2½ yrs	12 mos 4 mos 8 mos	12
Exploration	5	3 All were inoperable	2 postoperatively				
No operation	5		5				
Excision tumor	1	1					
Loin incision	1		1 one year postoperatively				
No mention of type of operation	3	1	2				
Total	93	28	40	4	21		

Of the 78 patients who had nephrectomies, there was no follow up in 23. Thirty died, 19 of these postoperatively. The causes usually given were shock and hemorrhage. It was quite obvious that a number of these patients had multiple metastases at the time of operation, and never should have had a nephrectomy. Nine others died within the first year, and two died after living six and eight years respectively. The former had four operations and died of recurrence, the latter of pulmonary tuberculosis.

Recurrence occurred four times: eight months, one year and seven months, and three years, and in one no time was stated. Twenty-one patients are living, fifteen less than one year. Six have passed the first year, three of whom have lived beyond the five year period. Of these latter three, one has lived 20 years, but the histologic diagnosis of sarcoma seems to be in doubt. One patient with a fibrosarcoma lived six years and three months, although an operative note stated that not all the tumor was removed. The third is apparently well after seven years. It is significant that in the 55 cases where a follow up was obtained only one patient (2 per cent) can be said to be cured.

Five patients were submitted to an exploratory laparotomy. Of these, two died postoperatively and at necropsy showed multiple metastases. Three were found inoperable. These patients were discharged from the hospital and no follow up was obtained.

In the group of five, where no operation was performed, all died and the necropsies revealed extension of the neoplastic process elsewhere. In the three cases where no mention was made of any operation, two died. There was no postoperative examination in the third. The patient who had a loin incision died a year following the operation.

CASE REPORTS OF ELEVEN INSTANCES OF SARCOMA OF THE KIDNEY  
OCCURRING IN ADULTS

**Case 1**—G U No 301453 B T S A white, married, native housewife, age 39, entered the Massachusetts General Hospital September 11, 1929, complaining of hematuria of two weeks' duration. The patient had been in perfect health until two months previously, when she noticed a dull ache in the right flank. This discomfort was not increased by movement or physical exertion. There was no radiation of the pain downward. With the exception of nocturia there were no other accompanying genito-urinary symptoms. Two weeks before entry to the hospital hematuria occurred for the first time. It was insidious, painless and total in character. Clots were often passed. Chills and fever were present. There was some stiffness of the right hip and leg, and pain along the entire right lower extremity. The hematuria persisted up to the time of admission to the hospital.

*Physical Examination* at this time revealed nothing abnormal above the diaphragm. There was marked tenderness in the right costovertebral angle and right flank but the kidney on that side was not palpable. There was spasm of the psoas muscle. Vaginal and rectal examinations were negative.

*Cystoscopy* showed a normal bladder. Both ureters were easily catheterized, and bilateral pyelograms were made.

*Röntgenologic Examination*—The right kidney pelvis was incompletely filled and only the lower calyx was visible. The left renal pelvis appeared normal. Findings on the right side were consistent with carcinoma of the kidney pelvis.

Röntgenograms of the chest, vertebrae, pelvis and upper extremities failed to show any evidence of metastasis.

*Laboratory Data*—The blood nonprotein nitrogen was 26 mg. The Hinton test was negative. Intravenous phenosulphophthalein showed 50 per cent excretion in the first and 15 per cent in the second hour.

*Operation*—September 28, 1928. Under ether anesthesia, the right kidney was exposed through a retroperitoneal incision and found to be surrounded by thick adherent fat which was cleared away with some difficulty. There was a tumor mass situated at the upper pole of the kidney. The kidney was removed.

*Pathologic Report*—*Gross*. A slightly enlarged kidney, 13 x 6.5 x 5 cm. in size and weight 260 Gm. There is a nodule mass situated at its upper pole. *Microscopic Examination* showed it to be a fibrosarcoma.

The patient made an uneventful convalescence and was discharged from the hospital 20 days postoperatively. Two months later the husband reported that the patient had died.

**Case 2**—G U No 298303 C B A white housewife, age 53, entered the Massachusetts General Hospital April 20, 1929, complaining of pain on the right side, loss of weight, and anorexia. Four months previously, the patient had begun to lose her appetite, she also vomited occasionally. She continued losing weight. Constipation was noted about four months ago, and she also noticed an increase in the pain in the abdomen, which seemed to be relieved somewhat by the passage of flatus. It was, however, at times very intense. Sometimes it would radiate across the entire abdomen and to the back. She had noticed a definite swelling of the abdomen. There were never any urinary symptoms such as frequency or nocturia.

*Physical Examination* showed a rather thin emaciated female presenting a yellow skin and fine tremor of the hands. Heart and lungs apparently normal. Abdominal examination showed a marked protrusion of the right side, which proved to be a firm mass the size of a soccer ball, which filled the entire right side of the abdomen. It did not appear to be connected with the liver, nor did it move with respiration. It extended to the brim of the pelvis, and was fairly movable. On percussion in the flank, the mass

seemed to be dull, but was tympanitic anteriorly. Pelvic and rectal examinations were essentially negative.

*Roentgenologic Examination*—A barium enema showed a large mass in the right upper quadrant extrinsic to the colon, around which the colon looped. There was some deformity of the intestine, probably due to pressure, but no evidence of intrinsic disease of the colon itself.

*Cystoscopy* showed a normal bladder. Both ureteral catheters passed to each pelvis without obstruction.

A pyelogram of the right kidney pelvis showed it to be markedly distorted. It was apparently displaced upward and outward by a mass below it, which was interpreted as being consistent with tumor of the kidney. Left pyelogram was negative. Roentgenograms of the lungs, bones, and chest showed no evidence of any metastatic process.

*Laboratory Data*—Red blood count 4,390,000, leukocytes 11,600, differential 70 per cent polynuclear cells, 7 per cent monocytes, with 23 per cent lymphocytes. Hemoglobin was 70 per cent. Icteric index 4. The blood nonprotein nitrogen was 30 mg. The renal function was 40 per cent in two hours.

Urine examination was essentially negative.

*Operation*—May 1, 1929. A right nephrectomy was performed through a transperitoneal right-angle incision under spinal anesthesia and ether. A large kidney was found which was firmly adherent to the ascending colon. It was evident that in order to remove the kidney, the colon itself would have to be resected. It was, therefore, cut across below and above the kidney and a side-to-side anastomosis effected. The kidney was removed with the resected portion of the colon. The patient was given a transfusion of 500 cc of whole blood.

*Pathologic Report*—Gross. The specimen was a mass 24 x 12 x 11 cm in size and weighing 720 gm. It consisted of a large irregular, firm nodular mass of whitish tissue surrounding the upper pole and anterior surface of a normal sized kidney. Attached to its upper anterior surface was a section of normal appearing colon 35 cm in length. There were several firm, round, white nodules 1 to 2 cm in diameter in the mesocolon. Section showed the upper pole of the kidney to be occupied by a spherical mass of fairly firm, yellowish-white tissue displacing but not invading the renal tissue. The tumor tissue above this was fairly firm, homogeneous and of a light yellowish color. In the portions more distant from the kidney the tumor was made up of a firm, homogeneous white tissue.

*Microscopic Examination* showed the presence of two different types of tumor. One was made up of large vacuolated cells arranged in solid masses and in places in long tubules and having the typical appearance of a renal adenocarcinoma. The other was composed of closely packed, poorly differentiated spindle shaped cells. Mitotic figures were numerous, and multinucleated forms common. The appearance was that of a very rapidly growing and highly malignant fibrosarcoma. In places the two types of tumor were intermingled. Several interpretations are possible. Two primary tumors, a mixed tumor, or a malignant degeneration of the stroma in a primary renal adenocarcinoma, the first being considered the most likely.

The patient did very well until eight days following the operation, when a fecal fistula developed. Intestinal obstruction occurred, and shortly afterwards the patient died of bronchopneumonia, probably terminal.

*Autopsy* (35573) showed a fecal fistula, sepsis in the operative wound, and metastases from the fibrosarcoma to the liver and peritoneum.

*Case 3*—G U No 261511. E S. A white, English housewife, age 46, entered the Massachusetts General Hospital March 4, 1924, complaining of pain in the epigastrium and right hypochondrium of three weeks' duration. Three weeks previously the patient had been seized with a severe knife like epigastric pain radiating to the right hypochondrium and right back. It was accompanied by vomiting. This lasted for a few

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days but gradually disappeared, leaving a "sore ache" in the right back. The pain was not related to the intake of food. There were no urinary symptoms.

*Physical Examination* showed a large, firm, slightly movable mass on the right side, extending downward to the right iliac crest. It was regular in outline and not tender. Pelvic and rectal examinations were negative.

*Cystoscopy* showed a normal appearing bladder. Both ureteral orifices were easily catheterized. A pyelogram of the right kidney pelvis showed the right kidney shadow to be normal in size, but rather peculiar in outline. Although the calices were made out and showed apparently the normal cupping, the appearance suggested that the peculiarity in the shape of the shadow of the pelvis was due to rotation rather than actual deformity. The outline of the left kidney showed it to be apparently normal in size and shape. The barium enema and Graham tests were negative.

*Laboratory Data*—The blood nonprotein nitrogen was 50 mg. White blood count 9,200. Hemoglobin was 90 per cent. The urine contained 20 to 25 white blood cells.

*Operation*—March 8, 1924. A renal tumor was removed through a transperitoneal right rectus incision.

*Pathologic Report* (3-24-24)—The kidney was covered with a thick, purplish-red tissue with a friable purplish-red mass (the size of a small orange) at the lower pole. On section it was largely composed of soft necrotic tissue and blood clot.

*Microscopic Examination*—Lipoleiomyosarcoma.

The patient was discharged 15 days postoperatively.

*Case 4*—G. U. No. 286928. J. A. L. A native, white, married male, age 48, entered the Massachusetts General Hospital October 24, 1927, complaining of loss of weight, and intermittent attacks of pain in the right flank of 12 years' duration. Twelve years ago the patient experienced for the first time a sudden sharp severe pain in the right flank which awoke him from his sleep, and caused him to "double up." A roentgenologic report stated that he had stones in his kidney. There was a previous history of his having passed gravel at various times.

*Present History*—For 12 years the patient had been asymptomatic. Six months ago he began to lose weight, and his appetite was markedly decreased. There was a history of a 60 pound weight loss in six months. Three days ago he complained of insidious hematuria with clots. Nocturia was present, diurnal frequency six to eight times. There was a history of attacks of renal colic dating back three months accompanied by very slight hematuria, and some intestinal symptoms.

*Physical Examination* showed a fairly well developed and well nourished man in no obvious discomfort. Blood pressure 110/65. There was some tenderness in the right costovertebral angle. A smooth, movable mass was palpable which did not move much on respiration. The mass extended down to within one inch of the iliac crest, and anteriorly over to the midline.

*Cystoscopy* showed a normal bladder. A thick swirl of pus was seen coming from the right ureteral orifice. A pyelogram of the right kidney pelvis showed an abnormality, in conjunction with a large calculus.

*Laboratory Data*—The urine was infected. The blood nonprotein nitrogen was 30 mg.

*Operation*—October 27, 1927. A right nephrectomy was performed under ether anesthesia. A preoperative diagnosis of calculus pyonephrosis had been made. The patient was discharged one month after operation, with a small draining sinus.

*Pathologic Report*—Gross. A cystic and solid tumor the size of a child's head measuring 8.5 x 12 x 18 cm. It had the gross appearance of a pus kidney. On section the pelvis and calices were dilated with pus. There was a friable tumor mass the size of a billiard ball which projected from the surface of the pelvis, and a large branching stone was beside it. One pole was considerably larger than the other and on section it had an opaque grayish-white surface and formed a wall 2.5 cm. in thickness about

central dilated calices The remaining third of the kidney was apparently not involved in tumor and the parenchyma formed a thin shell about the pus filled calices

*Microscopic Sections* through the peripheral portion of the tumor showed large alveolar clusters of atypical, fairly well differentiated squamous cells with numerous cells in mitosis The polypoid tumor in the pelvis had the structure of a spindle cell sarcoma It was composed of pleomorphic cells, many of them elongated and spindle in shape and arranged in bundles There were many huge multinucleated giant cells and many cells showed mitosis The growth was disintegrated and filled with wandering cells and blood It is probable that the two different forms of neoplasms had arisen from a malignant degeneration of a teratoma Diagnosis Squamous cell carcinoma Spindle cell sarcoma Pyonephrosis Nephrolithiasis

**Case 5**—G U No 285549 F S A white, foreign housewife, age 45, entered the Massachusetts General Hospital August 18, 1927, complaining of pain in the left back and lower left abdomen of six months' duration For the past six months she had had intermittent attacks of dull pain in the left kidney region, radiating to the left lower quadrant The pain came on two or three times weekly Occasionally the pain was severe, but was never associated with any other urinary or gastro-intestinal symptoms The pain became progressively worse and more frequent Three days before entry to the hospital the patient experienced a very severe pain in the left flank which seemed to radiate over the entire abdomen There was some nausea but no vomiting Frequency of urination occurred at this time This attack lasted for a few hours and did not recur until the night before admission A history of constipation was present, but no weight loss

*Physical Examination* was negative except for a firm, rounded, smooth, rather tender mass in the left kidney region, about the size of a large orange There was some costo-vertebral tenderness present on this side

*Cystoscopy* showed a normal appearing bladder A pyelogram of the left kidney pelvis showed a marked deformity present There were some small areas of calcification present which looked like stones Roentgenograms of the chest and bones were negative Barium enema was also negative

*Operation*—August 22, 1927 A left nephrectomy was performed, the kidney being removed by morcellation A hemorrhagic cyst was present The patient was discharged October 19, 1927, and died October 28, 1927

*Pathologic Report* (27-8-119)—The kidney weighing 350 Gm and measuring 15 x 8 x 9 cm The pelvis was tremendously dilated Projecting into it was a necrotic tumor 8 cm in diameter At one pole of the kidney a small rim of kidney parenchyma was left

*Microscopic Examination* showed a tumor composed of spindle cells, very rapidly growing, with many mitotic figures and numerous giant cells There was little stroma Many of the cells strongly suggested smooth muscle in appearance Diagnosis Leiomyosarcoma

**Case 6**—G U No 230219 E T A white Italian clerk, age 37, entered the Massachusetts General Hospital May 9, 1919 There was a history of influenza of two years' duration Four days ago the patient began to vomit without any apparent cause, and continued to do so all day The vomiting lasted one and one-half days, when he noticed that his urine was red There were no other genito-urinary symptoms, but slight nausea, without pain continued The patient's bowels were always irregular He developed a moderate frontal headache which lasted for two days, accompanied by dizziness and blurred vision An abdominal mass had been recognized five months previously

*Physical Examination*—The patient appeared to be a well developed and well nourished male Heart, neck, and lungs were all negative There were no enlarged nodes anywhere Abdominal examination revealed a fulness and distention on the right side A mass filled the entire left upper quadrant and extended downward to the anterior superior spine on that side, and over to the midline The mass was round, smooth, and not fixed There was a marked varicocele in the left scrotal sac The

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patient's renal function was very low. The pyelogram was consistent with polycystic disease of both kidneys.

*Laboratory Data*—The urine showed nothing abnormal except a slight trace of albumin. The sediment showed many red and white blood cells. The blood nonprotein nitrogen was 122 mg. Hemoglobin 55 per cent.

*Operation*—May 10, 1919. An exploratory operation on the left kidney was performed under ether anesthesia. The diagnosis of polycystic disease of the kidney was made. Two days following operation, the patient became distended, and his respirations increased and became labored. This increased in severity, and the patient died five days after the operation.

*Autopsy* (No. 3951), May 13, 1919. Bilateral lipoleiomyosarcoma of the kidneys. Septicemia.

**Case 7**—E. S. No. 207226. W. R. M. A white native painter, age 48, entered the Massachusetts General Hospital April 13, 1916, complaining of pain in the left upper quadrant. Two months ago he had the first attack of burning pain in the left upper quadrant, lasting all night. This was accompanied by nausea and vomiting. He did not notice anything peculiar in the urine. One month later he had a similar attack and passed quite a large amount of blood and clots in the urine. Since this time, he has had persistent hematuria, and marked frequency. During the last three weeks, he has had much nausea and vomiting. On two or three occasions, the vomitus contained blood. At the time of entry in the hospital the patient complained of severe upper quadrant pain which was worse at night. His abdomen had begun to swell, and he himself noticed a very large mass.

*Physical Examination* showed a fairly well nourished man. Heart and lungs were negative. There was no evidence of enlarged nodes. The abdomen was full, and the entire left side of the abdomen was occupied by a large, rounded, nodular, fixed mass which extended over to the right side. It was not tender, and did not move with respiration. The lower pole of the mass was on the crest of the ilium.

Barium enema showed no intrinsic disease of the colon.

*Operation*—March 18, 1916. A left upper rectus incision was made which was connected at the lower end with another horizontal incision through the rectus muscle. A large cystic mass was found. The colon was adherent, but was easily freed. The mass was aspirated, and contained about two quarts of very dark fluid. The kidney was removed.

The patient did not cooperate, refusing to take any nourishment, and had to be tube fed. He died nine days after the operation.

*Pathologic Report*—Gross. An irregular cystic tumor about the size of a child's head. The capsule contained more or less fat with a few nodules of new growth on the surface. Dissection showed multiple cysts which communicated by narrow connecting necks with each other and with the pelvis. The lining of the cavities was smooth except for a number of small pedunculated white to reddish-brown masses of firm fleshy consistency. Lying loose in the cavity were two rather large mulberry calculi. In the kidney substance there was a new growth, grayish to brownish-red on section.

*Microscopic Examination* showed a growth to be composed of masses of large cells with a little intercellular substance and with sinus like cavities without distinct walls. **Diagnosis.** Large mixed cell sarcoma.

*Autopsy* (No. 3573) showed sarcoma of the kidney with metastases to the lungs, pleura, and diaphragm.

**Case 8**—W. S. No. 235884. E. A. F. A white native housewife, age 41, entered the Massachusetts General Hospital March 29, 1920, complaining of pain in the right groin and flank of one year's duration. The patient was perfectly well until one year ago when her pain began. At times it was rather severe but for the most part was more of a constant dull ache. Lying down seemed to aggravate the pain, while standing up

lessened it. About four months ago during an episode of pain the patient had a miscarriage. For the past two weeks the patient has been practically free from pain.

*Physical Examination* determined a hard, movable mass in the right upper quadrant. A pyelogram of the right kidney pelvis showed a moderate hydronephrosis. Both ureters were displaced to the right, but the displacement was more marked on the right side. A Graham test was made, and the gallbladder found to be negative. Barium enema was also negative.

*Laboratory Data*—The urine showed an occasional white blood cell. White blood count 10,400. Hemoglobin 90 per cent.

*Operation*—April 7, 1920. Through a transperitoneal incision a mass was found arising from the inner aspect of the upper pole of the right kidney which extended medially and downwards. It was adherent to the vena cava. The kidney was removed. Five small holes were torn in the vena cava which were tied with No. 0 chromic catgut. The patient was discharged April 26, 1920. On June 15, 1921, no evidence of recurrence was found.

*Pathologic Report* (20-4-29)—*Gross*. The kidney was 10 cm long. A tumor weighing 628 Gm was attached to the upper pole. On section the kidney showed no invasion of the parenchyma. The pelvis and calices were dilated. The tumor was intimately connected with the pelvis and compressed the ureter.

*Microscopic Examination*. Leiomyosarcoma.

*Case 9*—H. O. No. 268850. V. A. A Greek machine cleaner, age 57, entered the Massachusetts General Hospital March 31, 1925, complaining of a "lump" in his right side. About four months ago, he said he first noticed a "lump" in the right upper quadrant, at that time the size of a nut. At first it was not tender, but was movable. The mass started growing rapidly until now it is the size of a grapefruit. It is tender at the present time, but still movable. For the past four months, there has been a weight loss of 15 pounds, in spite of this, the patient says he has a good appetite.

*Physical Examination* showed a thin, emaciated male, prematurely old, who showed evidence of weight loss. He appeared anemic. Both the inguinal and epitrochlear nodes on both sides were palpable. In the right upper quadrant, there was a firm, irregular, rounded mass, slightly tender and which felt like kidney. The mass moved with respiration. On entry, the patient passed about six ounces of bright red blood.

*Cystoscopy* demonstrated blood coming from the right ureteral opening.

*Röntgenologic and Pyelographic Report* (No. 115441)—May 3, 1925. Kidney outlines were not visible on either side. Films taken with radiopaque catheters in position showed an area extending from the tip of the twelfth rib downward across the psoas muscle to the spine and overlying the upper border of the ilium, in which there were dense irregular shadows. These shadows were more dense than bone and probably represented calcified masses. The pelvis of the right kidney occupied the center of the region just described. The pelvis was large with a smooth outline. Calices were also increased in size, particularly the upper. There was absence of the middle calix, and in none was the usual cupping present. The appearance was that of an hypernephroma.

May 4, 1925. In the posterior part of the right parietal bone there was an area of diminished density about 2 cm in diameter which was quite round with sharply defined margins and in which the bone trabeculae were indistinct. No proliferative changes were present. This appearance was very suggestive of metastatic malignant disease. Other bones examined appeared normal. Chest was negative.

*Laboratory Data*—Red blood count 3,830,000, white blood count, 15,700. The blood nonprotein nitrogen was 30 mg. Differential 87 per cent polynuclear, 9 per cent lymphocytes, 4 per cent large mononuclear cells, no eosinophiles or basophiles, platelets diminished, red blood cells showed marked achromia, slight anisocytosis, and polychromatophilia. Hemoglobin 60 per cent.

Urine was red in color, and there was some frequency and urgency present. His son stated that at times he had noticed some clots in his urine. Hematuria was only of six months' duration.



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*Operation*—April 4, 1925 A right nephrectomy was performed through an eight-inch right rectus incision. No metastases were found in the liver. The posterior layer of the peritoneum was opened. A much enlarged kidney was removed and found to consist of a normal appearing kidney with a typical hypernephromatous growth on the anterior surface. A node about two inches long was felt on the anterior surface of the aorta and was removed. Another indurated area was felt in the region of the pedicle but was not disturbed. A rubber drain was inserted through the flank. The patient did remarkably well after the operation. Before discharge 18 days postoperatively, the wound was almost all healed. No follow up.

*Pathologic Report* (25-1-17)—*Gross* A large, nodular tumor measuring 14.5 cm in diameter. On section it filled all the renal substance except at one pole. Its surface was lobulated and largely necrotic with large areas of bony hardness in its center. Soft purplish-red lobules invaded the renal substance. The pelvis was dilated and contained a plug of soft tumor, about the size of an English walnut, adherent to its inner surface. A hard nodule, the size of a golf ball, was separate. It showed a white fibrous surface on section.

*Microscopic Examination* showed a mixed or teratomatous growth with both a sarcomatous and a carcinomatous arrangement. There were areas of large granular cells which were often vacuolated and massed together between thin walled blood vessels presenting a structure resembling the adrenal cortex. Other areas showed an adenomatous structure and contained small irregular gland tubules lined by rather large cuboidal epithelial cells, usually in a single layer with a lymphoid stroma between the tubules. The sarcomatous portions were composed of bundles of spindle cells, but the majority of the cells were pleomorphic with numerous giant cytoplasmic masses having multiple nuclei. About some of these pleomorphic cells, there were bands of hyaline like intercellular substance, which resembled osteoid tissue. Diagnosis: Embryonal mixed tumor with a regional metastasis.

*Case 10*—B M No 20648 A D A A white native lady, age 56, entered the Baker Memorial Hospital October 20, 1935 complaining of a constant dull ache in the right loin of three months' duration. The present illness dates back one year, when the patient noticed that she was getting more and more tired doing less and less work. Nausea and vomiting came on intermittently, and later on, the patient noticed weight loss.

*Physical Examination*—A mass could be palpated in the right upper quadrant. It was not tender, slightly fluctuant, and movable. The liver was enlarged.

*Röntgenologic Examination* demonstrated fluid in the right pleural cavity. There was some question of metastatic involvement in one of the lower right ribs.

*Laboratory Data*—Red blood count, 4,240,000, white blood count, 210,500. Differential: 91 per cent polynuclear cells, 1 per cent large lymphocytes, 2 per cent small lymphocytes, 4 per cent monocytes, and 2 per cent eosinophiles. The hemoglobin was 70 per cent.

*Operation*—October 26, 1935 An exploration of the right kidney was performed through an oblique kidney incision under ether anesthesia. The upper end of the incision passed through a swelling in the right back which had been noted before the operation. This proved to be a cavity lined with tumor tissue, and contained a thick oily fluid. The incision was then carried down and the kidney exposed. It was slightly larger than normal, and paler, with an irregular consistency and a hard woody feel. The ureter was cut and tied. The kidney was easily freed as the growth did not appear to have penetrated the capsule. The pedicle was not infiltrated. The pedicle was clamped and the kidney was removed. Some of the fatty capsule was removed. The right lateral border of the spine appeared to be rather prominent and irregular as if there had been metastasis to the tissue lateral to it. On palpating the chest wall from within the kidney wound, the tissues in the region of the metastasis felt nodular and thickened. It seemed as if the growth had passed between the ribs rather than originating in them. One cigarette wick was used. The wound was closed in layers.

TABLE V  
RESULTS OF 93 CASE REPORTS OF SARCOMA OF THE KIDNEY OCCURRING IN ADULTS

Author	Sex	Side	Age	Symptoms	Pathologic Diagnosis	Operation	Follow Up
1 Cook <sup>10</sup>	F	R	60	Mass right renal region	Malignant leiomyoma	Exploration	Died bronchopneumonia Autopsy showed metastases to liver peritoneum and omentum No urinary symptoms
2 Swan <sup>11</sup>	M	L	51	Pain and hematuria	Mixed cell sarcoma	Nephrectomy	Recurrence in lungs in 8 mos
3 Swan	M	L	71	Hematuria	Leiomyosarcoma	Nephrectomy	Well after 12 mos
4 Swan	M	L	55	Hematuria	Spindle cell sarcoma	Exploration	Inoperable
5 Naff <sup>12</sup>	F	L	58	Tumor of left side symptoms	Wilms' tumor	Nephrectomy	No evidence of metastases No follow up Weighed 13.64 Mlg
6 Crosby <sup>11</sup>	F	—	35	Pain lumbar region Frequency of urination	Leiomyosarcoma	Nephrectomy	No follow up
7 Herman and Greene <sup>1</sup>	M	L	38	Soreness in abdomen Gastro intestinal symptoms Cramps, vomiting, loss of weight	Sarcoma	No operation	Died Autopsy (restricted) Involvement of regional nodes Extension to right kidney Partial intestinal obstruction
8 Deuticke <sup>13</sup>	M	—	25	Pain kidney region Mass	Sarcoma	Nephrectomy	Lived 20 yrs ? of authenticity of record
9 Deuticke	F	—	39	Pain kidney region	Sarcoma	Nephrectomy	Died of recurrence after 6 yrs Had 4 operations during that interval for recurrence
10 Grove <sup>10</sup>	M	R	24	Hematuria Ache right lumbar region Nocturia 2 mos	Sarcoma	Nephrectomy	No follow up
11 Judd <sup>2</sup> (20 cases)	10 F 10 M	L (11) R (9)		Pain (17) Hematuria (7)	Fibrosarcoma Sarcoma Round cell Mixed cell Myxosarcoma Liposarcoma Spindle cell Fibromyxosarcoma	Nephrectomy 19 cases Biopsy and Exploration 1 case 1 case 3 cases 1 case	Died postoperatively 3 cases Lived less than 1 yr 12 cases Lived 8 yrs and then died 1 case ? tuberculosis Died during first year—pneumonia 1 case Living 2 yrs and 3 mos 1 case Living 4 mos 1 case Living 6 yrs and 3 mos (This was a fibrosarcoma Grade 3) 1 case Did not remove all growth at operation 1 case
30 Crutchfield <sup>1</sup>	F	L	27	Pea sized growth on each side of nose, cheeks and forehead Pain left side	Wilms' tumor	No operation	Autopsy—tumor of left kidney adherent to left diaphragm and lumbar muscles
32 Kilbuck <sup>1</sup>	M	L	48	Pain left flank Hematuria	Embryonal adenomyosarcoma	Nephrectomy	Died 24 hrs postoperatively
33 British Journal of Surgery <sup>14</sup> Thatcher <sup>15</sup>	M F	L R	35 59	Hematuria 4 da Dull ache left side Pain at tip of penis Mass Severe pain right side Occasional vomiting Mass—1 yr	Spindle cell Mixed tumor	Nephrectomy Nephrectomy	Well 7 yrs postoperatively No follow up Osseous tissue found in center of tumor

# SARCOMA OF THE KIDNEY

35	Vermotten <sup>1</sup>	M	L	34	Hematuria Pain left side Mass of weight—20 lbs in 2 mo <sup>2</sup>	Spindle cell	Nephrectomy	No follow up	Weight 12700 gm
36	Thomas <sup>10</sup>	M	L	64	Burrowing, with no relation to food about umbilicus—1 yr	Round cell Mixed cell	Nephrectomy	Died 12 hrs postoperatively ely Hem- orrhage	
37	Kretschmer and and Randolph <sup>17</sup>	F	L	49	Hematuria pain tumor	Spindle cell	Nephrectomy	No follow up	
		F	—	46	Hematuria tumor	Spindle cell	Nephrectomy	No follow up	
		M	L	59	Hematuria, pain tumor	Spindle cell	Nephrectomy	Good recovery ely, no return kidney pelvis	
		F	R	24	Hematuria, pain tumor	Spindle cell	Nephrectomy	Good recovery ely, no return kidney pelvis	
		M	L	55	Pain, tumor varicocele, Gr I lymphoma <sup>18</sup>	Spindle cell	Nephrectomy	Recurrence in 1 yr 7 mo <sup>19</sup>	
		F	L	45	Pain, tumor	Spindle cell	Nephrectomy	Notified	
		M	L	51	Pain, tumor, edema	Spindle cell	Nephrectomy	Died some days after	
		F	R	39	Pain tumor, loss of weight	Spindle cell	Nephrectomy	Died 10 minutes after nephrectomy	
		F	R	68	Tumor, loss of weight	Spindle cell	Nephrectomy	Died 11 da after nephrectomy	
46	Hasner <sup>22</sup>	F	R	54	Pain edema and varicocele	Spindle cell	Nephrectomy	Recd crf	
47	Hasner <sup>22</sup>	M	R	45	Pain right humerus region I frequency Polycystic Hematuria—1 mo Mass Varicocele—2 mo <sup>2</sup>	Mixed tumor	Nephrectomy	Mortality to nodes alone not 1 yr 1 yr postoperatively ely	Died
48	Holmes <sup>6</sup>	M	L	44	Fever, malaise chills sensation <sup>2</sup> Pain left kidney Loss of weight Mass Colic at times	Spindle cell	Nephrectomy	No follow up	
49	Pepper <sup>10</sup>	M	L	59	C.C. varicocele Mass Loss of appe- tite and weight Anemia Microscopic hematuria	Spindle cell	Laparotomy	Inoperable	No follow up
50	Ralphs <sup>12</sup>	F	R	39	Swelling right side	Spindle cell	Nephrectomy	Involution of pedicle after operation	Died few minutes
51	Bruce <sup>7</sup>	M	R	50	Feeling of abdominal distension Debili- ty Flatulence Indigestion—1 yr Mass	Fibrosarcoma	Nephrectomy	Died 1 yr postoperatively Perito- nitis	
52	Davis <sup>13</sup>	F	—	60	Tumor General malaise Loss of appe- tite Frequency—6 mo <sup>2</sup>	Teratoma (malignant)	Nephrectomy	Died 27 da after operation No necropsy	
53	Oraison <sup>19</sup>	M	R	23	Loss of weight Pain sacrohumeral re- gion Mass right side No urinary symp- toms	Sarcoma	Nephrectomy	Died 3 da postoperatively. Marked anemia	
54	Berry <sup>3, 4</sup>	F	R	43	Pain right flank Hematuria	Fibrosarcoma	Partial nephrectomy	Died postoperatively	
55	Berry	F	L	35	Mass—left upper quadrant Anemia	Adrenal carcinoma	Nephrectomy	Died 8 da postoperatively	
56	Berry	M	R	72	Splenic enlargement Loss of appetite Mass	Papillary carcinoma Leiomyosarcoma Adrenal cell sarcoma	Nephrectomy	No follow up	
57	Lutenbacher <sup>24</sup>	F	L	36	Loss of weight Tumor of left side Dysp- nea Cyanosis Pulmonary symptoms	Fibrosarcoma	No operation	Necropsy showed tumor of left kidney	
58	Hinman <sup>5</sup>	M	R	50	Pain lower abdomen Mass right side Hematuria—2 wks Morning vomiting —5-6 yrs	Sarcoma	Inoperable	Necropsy metastasis to liver, pan- creas, and abdominal nodes	
59	Downes <sup>16</sup>	F	—	34	Asthma—10 yrs Mass right side Pain right lower abdomen—1 yr Birth child 10 wks ago Lump noticed Loss of weight	Embryonal adenocarcinoma	Nephrectomy	No follow up	
60	Heppner <sup>23</sup>	F	L	71	Mass Pain left side No hematuria	Spindle cell sarcoma	Nephrectomy	Recurrence	
61	Heppner	F	R	47		Sarcoma	Nephrectomy		

TABLE V (Continued)

Author	Sex	Side	Age	Symptoms	Pathologic Diagnosis	Operation	Follow Up
62 Hopper	F	—	26	Increasing mass—9 years' duration	Spindle cell sarcoma	Liparotomy	
63 Lieberman <sup>23</sup>	—	L	—	Tumor Pain No hematuria	Fibrosarcoma	Nephrectomy	Died
64 Baumann	M	R	59	Hematuria	Embryonal mixed tumor	Nephrectomy	No follow up
65 Alliman and Bayer <sup>1</sup>	F	R	40	Mass Necrotic tumor	Spindle cell sarcoma	Nephrectomy	No follow up
66 Roth and Schweerer <sup>44</sup>	F	L	43	Pain Tumor Hematuria Resection of thrombus	Spindle cell sarcoma	Nephrectomy	Died 3 da later of uremia
67 Clay <sup>9</sup>	F	R	80	Pain Mass Urine negative	Embryonal myosarcoma	Nephrectomy	Good recovery
68	F	R	39	Late hematuria Mass	Fibrosarcoma	Nephrectomy	Died 2 mos postoperatively
69	F	R	53	Gastro intestinal symptoms	Adenocarcinoma	Nephrectomy	Died 8 da postoperatively
70	F	R	46	Gastro intestinal symptoms Pain (colic)	Fibrosarcoma	Nephrectomy	No follow up
71 Massachusetts General Hospital	M	R	48	Pain right flank—12 yrs Loss of weight	Squamous cell Stones	Nephrectomy	No follow up
72	F	L	45	Pain Gastro intestinal symptoms	Spindle cell carcinoma	Nephrectomy	Died 1 mo postoperatively
73	M	R & L	37	Gastro intestinal symptoms Mass	Leiomyosarcoma	Nephrectomy	Died postoperatively
74	M	L	48	Pain Hematuria Nausea Vomiting	Bilateral sarcoma (lipoleiomyosarcoma)	Liparotomy	
75	F	R	41	Pain	Mixed cell sarcoma Calculi	Nephrectomy	Died 11 da postoperatively
76 Palmer and Boylan <sup>17</sup>	M	L	65	Mass left kidney region Nausea vomiting—2-3 months' duration Loss of weight (15-20 lbs) Constipation, anorexia	Leiomyosarcoma Reticular cell sarcoma (reticulocytoma)	Nephrectomy Loin incision	Well 1 yr and 3 mos postoperatively Died 1 yr postoperatively Postmortem metastasis to suprarenal lymphatics Nodules in mesentery and lungs
77 Martin and Levrat <sup>35</sup>	M	R	50	Mass right hypochondrium	Rhabdomyosarcoma	No operation	Died Autopsy adrenal invaded Retroperitoneal nodes around vena cava invaded Metastases (multiple) to lungs Died
78 Watson and Russell <sup>5</sup>	M	R	45	Headache Pain in lumbar region	Spindle cell sarcoma	Nephrectomy	Died 2 mos postoperatively
79 Suto	M	R	26	Dull constant ache Right costovertebral pain of 3 months' duration Fatigue—1 yr Nausea vomiting Loss of weight	Mixed tumor		
80 Smith	F	R	56		Fibrosarcoma (edema of leg)		
81 Smurnov and Zamkova <sup>46</sup>	M	L	31	Hematuria Piercing pain left side—6 mos Painless swelling left side—5 mos	Mixed tumor	Nephrectomy	Died 3 hrs postoperatively
82 Rhode C <sup>43</sup>	M	R	52	Pain right kidney region Slight pain, left kidney region—1 yr	Mixed tumor	Nephrectomy	Died coma 1 mo postoperatively
83 Desnos <sup>11</sup>	M	L	48	Pain left side—2-5 yrs Intermittent hematuria—9 yrs	Mixed tumor	Nephrectomy	Died 9 mos postoperatively Metastases and recurrence
84 Brugnatelli <sup>4</sup>	F	R	43	Painless swelling right side—5 mos Evening fever	Mixed tumor	Nephrectomy	No follow up
85 Ssorokov <sup>47</sup>	F	R	58	Severe pain right abdominal and lumbar region—2-3 wks Movable tumor—17 yrs Obstipation	Mixed tumor	Removal of tumor from kidney	Discharged 20 da after operation feeling fine

# SARCOMA OF THE KIDNEY

86 Soroko

F L

87 Brandts

M L

88 Brandt

M L

89 Smith

F R

90 Keefe<sup>30</sup>

F R

91 Geschlechter—Widen-  
horn<sup>19</sup>

M R

92 Massachusetts General  
Hospital

M R

93 Haining and Poole<sup>1</sup>

M L

34 Severe pain left lumbar region Pal Mixed tumor  
68 No mention  
37 Severe pain in iliac region 2 d<sub>1</sub> before Mixed tumor  
67 admission  
67 Gastro-intestinal symptoms—3 1/2 yr No arcoma  
14 Mass Mixed tumor  
10 Pain back and right loin Fibro arcoma  
57 upper quadrant Distention in right Embryonal sarcoma  
57 Hematuria Lump right side Sarcoma  
76 Frequency nocturnal dysuria No Osteoblastoma  
hematuria

Nephrectomy Well 8 mo postoperatively Able to  
work  
No mention Metastases to lungs and liver  
Nephrectomy No follow up  
Nephrectomy Well 2 1/2 yr postoperatively  
Nephrectomy Well 3 yr then had symptoms  
Nephrectomy Died  
Nephrectomy No follow up  
Nephrectomy Died Necropsy involvement of other  
kidney liver mesentery bowel Peri-

Following operation, the patient developed edema of both legs. The edema was thought to be nutritional, for the patient did not eat after the operation, and her appetite was very poor before the operation. The wound finally healed after a moderate degree of sepsis, and the patient was discharged November 27, 1935. She died one month later.

*Pathologic Report—Gross.* A kidney measuring 11 x 6 x 5 cm in size with the capsule attached. The specimen had been previously sectioned and the capsule removed, exposing a smooth pale cortical surface. The lower two-thirds of the organ were rounded and of soft consistency. The pelvis and first portion of the ureter for approximately 3 cm were filled with soft yellow finely granular tumor tissue, a direct extension of the neoplasm from the renal parenchyma. Only the upper pole of the kidney appeared relatively uninvolved in the neoplastic process, which showed numerous areas of finely granular yellow neoplastic tissue embedded in a pale white fibrous stroma. The renal vein could not be identified in the specimen. *Diagnosis.* Fibrosarcoma.

**Case 11—B. B.** A Russian-born housewife, age 67, entered the hospital June 12, 1933, complaining of kidney and intestinal trouble of three and one-half years' duration. She had apparently been well until about four years ago, when she noticed that her appetite had increased noticeably, and yet, she did not feel up to par. About this time she had intractable itching around the vulva, lasting about three months. Three and one-half years ago, she was thought to have had diabetes. She had lost about 20 pounds in weight. She has been constipated all her life. About three years ago the constipation became so intractable that no form of laxative would move her bowels. Associated with the onset of this obstipation was a sharp pain in the right hypochondriac region. Symptoms referable to the genito-urinary system have been so numerous the past year and a half that the patient does not really know what she has had, although she claims that she has had nocturia four or five times a night, frequency, occasional hematuria, dysuria, and incontinence. The urine has ranged from red to thick, smoky color.

*Intravenous Pyelogram (6/14/33)* showed a normal left kidney and a partially filled right pelvis.

*Diagnosis.* Right renal tumor, possible involvement of bowel.

*Operation—June 26, 1933.* A right nephrectomy and appendectomy were performed under avertin and gas-oxygen anesthesia. The right rectus incision was carried outwards for two inches at the lower end. The peritoneum was opened, and the tumor found to be pushing the posterior peritoneum forwards to the outer side of the ascending colon. The liver was smooth. The gallbladder was soft. No masses were felt suggesting extension of disease. The posterior peritoneum was incised over the kidney. The kidney was freed, the ureter cut and the pedicle tied with No. 3 catgut. The kidney was then removed and the pedicle again tied. Some extrarenal fat was removed. One cigarette wick was passed between the peritoneum and the abdominal wall into the renal fossa. The posterior peritoneum was then closed. The appendix, which was free and rather scarred, was removed and the stump buried. The peritoneum was closed without drainage. The abdominal wall was closed in layers. Convalescence was fairly smooth. When she was seen two years later, no evidence of recurrence was found.

*Pathologic Report (6-26-33)—Mixed tumor of the kidney, highly malignant. Healed appendicitis.*

### CONCLUSIONS

There is only one conclusion that can be drawn incontestably from this survey, namely, that adult renal sarcoma is just as lethal a tumor as embryonal carcinoma in children. End-results are available in 65 of 93 cases. Twenty-one are living, and only three have gone beyond five years. Of the three living who passed the five year period, there is some doubt about the

history of one, and very little chance for cure in another, as the record stated that not all of the tumor was removed during nephrectomy. The third patient is well after seven years.

It appears that regardless of the type of sarcoma, death usually intervenes

# BIBLIOGRAPHY

- <sup>1</sup> Alleman, B, and Bayer, R. Cancer of the Kidney. *Ztschr f urol Chir*, 14, 119-156, 1923
- <sup>2</sup> Baumann, W. Ein Fall von embryonalem Misch tumor der Niere bei einem 59-jährigem Mann. *Deutsche Ztschr f Chir*, 179, 102-108, 1923
- <sup>3</sup> Berry, F. B. Report of Two Cases of Combined Tumors of the Kidney in Adults. *J Med Research*, 40, 459-469, September, 1919
- <sup>4</sup> Berry, N. E. Leiomyosarcoma of the Kidney. *Canad M A J*, 20, 280-282, March, 1929
- <sup>5</sup> Brandt, F. Über 2 Fälle von Myosarkom in der Gegend des Nierenbeckens. (Quoted by Hans Neumann in *Ztschr f urol Chir*, 20, 349, 1926)
- <sup>6</sup> Brit J Surg (suppl.) 16, 207, 1928-1929. Atlas of Pathologic Anatomy
- <sup>7</sup> Bruce, H. A. Tumors of the Kidney. *Canad M A J*, 13, 13-19, 1923
- <sup>8</sup> Brugnatelli, E. Tumore misto del rene con nodulo osteo-blastomatoso. *Folia urologica*, 6, 54, 1911-1912
- <sup>9</sup> Clay, J. Developmental Mixed Tumor of the Kidney in a Patient Aged 80. *Brit Med Jour*, 2, 1083, December 27, 1930
- <sup>10</sup> Cooke, W. E. Malignant Leiomyoma of the Kidney. *J Path & Bact*, 37, 157, 1933
- <sup>11</sup> Crosbie, A. H., and Pinkerton, H. Malignant Leiomyoma of the Kidney. *J Urol*, 28, 27-32, January, 1932
- <sup>12</sup> Crutchfield, E. D. Adenoma Sebaceum Associated with a Teratoma of the Kidney. *Arch Dermat & Syph*, 2, 368-369, 1920
- <sup>13</sup> Davis, J. E. Neoplasia of the Kidney. *Am J Obst & Gyn*, 3, 479, 1922
- <sup>14</sup> Desnos, E. Note sur une tumeur mixte du rein. *Bull acad med*, Paris, 85, 384, 1921
- <sup>15</sup> Deuticke, P. Nierentumoren. *Deutsche Ztschr f Chir*, 231, 767-797, 1931
- <sup>16</sup> Downes, W. A. Large Embryonal Adenocarcinoma of the Kidney. *Nephrectomy ANNALS OF SURGERY*, 55, 634-635, 1912
- <sup>17</sup> Elmer, R. F., and Boylan, C. E. Reticular Cell Sarcoma of the Kidney. *Illinois Med Jour*, 66, 83-87, July, 1934
- <sup>18</sup> Fedoroff, S. P. Über feste Nierentumoren und ihre chirurgische Behandlung. *Ztschr f Urol* 16, 392-406, 1922
- <sup>19</sup> Geschickter, C. F., and Widenhorn, H. Nephrogenic Tumors. *Am J Cancer*, 22, 620-658, November, 1934
- <sup>20</sup> Grove, J. S. Sarcoma of the Kidney. *Illinois Med Jour*, 59, 432-437, June, 1931
- <sup>21</sup> Haining, R. B., and Poole, F. E. Osteoblastoma of the Kidney. *Arch Path*, January, 1936
- <sup>22</sup> Hanser, R. B. Mixed Tumors of the Kidney. *Arch Path*, 6, 240-246, 1928
- <sup>23</sup> Heppner, E. Zur kasuistik der Nierengeschwulste. *Ztschr f urol Chir*, 6, 145-161, 1921
- <sup>24</sup> Herman, L., and Green, L. B. Sarcoma of the Adult Kidney. *J Urol*, 27, 317, 1932
- <sup>25</sup> Hinman, F. Early Diagnosis of Renal Tumor. *Surg, Gynec and Obstet*, 24, 669-680, 1917
- <sup>26</sup> Holmes, R. J. Spindle Cell Sarcoma of the Kidney. *J Florida M A*, 14, 569, May, 1928
- <sup>27</sup> Hyman, A. Observations in a Series of 99 Renal Neoplasms. *Am J Surg*, 5, 102-127, Aug, 1928
- <sup>28</sup> Hyman, A. Aspects of Renal Neoplasms. *Surg, Gynec and Obstet*, 41, 298-310, September, 1925

- <sup>22</sup> Judd, E S, and Donald, J M Sarcoma of the Kidney in the Adult ANNALS OF SURGERY, 96, 1028, 1932
- <sup>23</sup> Keefe, J W Sarcoma of the Kidney Bost Med & Surg Jour, 163, 943-945, 1910
- <sup>24</sup> Kilbane, E F, and Lester, C W Embryonal Adenomyosarcoma of the Kidney in an Adult Surg, Gynec and Obstet, 49, 710-715, 1929
- <sup>25</sup> Kretschmer, H L, and Randolph, H S Spindle Celled Sarcoma of the Kidney in Adults ANNALS OF SURGERY, 88, 1033-1038, December, 1928
- <sup>26</sup> Liebmann, M Diagnosis of Kidney Cancer Ztschr f Urol, 16, 347-364, 1922
- <sup>27</sup> Lutembacher, M A Dysembryomes metatypiques des Reins Ann de med, 5, 434-450, 1918
- <sup>28</sup> Martin, J F, and Levrat, M Rhabdomyosarcoma du Rein generalise au poumon et a la surrenale Lyon med, 153, 577-581, May 13, 1934
- <sup>29</sup> McKenzie, D W, and Perkins, G A Renal Tumors Canad M A J, 20, 616-621, June, 1929
- <sup>30</sup> Neff, J H Massive Hemorrhagic Cyst in a Wilms' Tumor of the Kidney in an Adult J Urol, 28, 65-76, July, 1932
- <sup>31</sup> Nichols, B H, and Shiflett, E L Roentgenographic Studies in Diagnosis of Renal Tumors M Clin North America, 17, 1101-1125, January, 1934
- <sup>32</sup> Oraison and Faure Sarcome du Rein a allure anormale J de med de Bordeaux, 47, 60-62, 1920
- <sup>33</sup> Pepper, O H P Varicocele as the First Sign of Sarcoma of the Kidney M Clin North America, 10, 29-36, July, 1926
- <sup>34</sup> Phillips, G Renal Tumors Internat J Surg, 37, 322-325, July, 1924
- <sup>35</sup> Ralphs, F G Sarcoma of the Renal Pelvis Associated with Hydronephrosis Brit J Surg, 13, 190-192, 1925
- <sup>36</sup> Rohde, C Maligne Mischgeschwulste der Niere mit Papillom und Zottenkrebs-bildung des uropoetischen Apparates beim Erwachsenen Beitr z path Anat u z allg Path, 65, 573, 1919
- <sup>37</sup> Roth, H, and Schwoerer, B Beobachtungen uber Nierengeschwulste Beitr z klin Chir, 133, 227, 1925
- <sup>38</sup> Saito, I Mixed Tumor in Adult Sei-i-kwai M J, 38, 7, March, 1919
- <sup>39</sup> Smurnowa-Zamkowa, A J Zur Frage uber "gemischte embryonale Geschwulste" Ztschr f Krebsforsch, 22, 218, 1925
- <sup>40</sup> Sosoroko, N K Mischgeschwulste der Nieren bei Erwachsenen Ztschr f Urol, 25, 731-742, 1931
- <sup>41</sup> Swan, R H J New Growths of the Kidney with Analysis of 65 Cases Brit M Jour, 1, 606-610, April, 1933
- <sup>42</sup> Thatcher H S, and Fulmer, P M Mixed Tumor of the Kidney in an Adult South M J, 22, 188-189, 1929
- <sup>43</sup> Thomas, W H Sarcoma of the Kidney J Urol, 20, 460-462, October, 1928
- <sup>44</sup> Vermotten, V Tumors of the Kidney A Report of Three Cases New Eng J Med, 198, 125-129, March 8, 1928
- <sup>45</sup> Watson, E A, and Russum, B C Small Spindle Cell Sarcoma in an Adult J A M A, 103, 1700-1702, December, 1934



# PYOUMBILICUS ASSOCIATED WITH UMBILICAL CONCRETIONS

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Pyogenic infections of the umbilicus seldom occur in adult life and when encountered present several very interesting problems. In the first place, there are usually coexisting anatomic defects which act as precursors to these infections, secondly, they are usually associated with the formation of umbilical concretions, thirdly, these inflammatory reactions are prone to become chronic as they have a pernicious tendency to recur, and, lastly, they eventually terminate in serious complications. An appreciation of these facts can best be emphasized by actual case presentations.

## PERITONITIS FOLLOWING THE SPONTANEOUS RUPTURE OF AN UMBILICAL ABSCESS WITH THE ESCAPE OF PUS AND THE EXTRUDED UMBILICAL CONCRETION INTO THE ABDOMINAL CAVITY

**Case 1**—A physician age 26, entered the hospital because of a "painful umbilicus." Seven years ago he first experienced a deep seated muscular pain in the umbilical region. A few days later a firm inflammatory intumescence appeared at the "navel" and slowly spread toward the bladder. He suffered from a pronounced urgency and frequency of urination but repeated urinalyses failed to show any pyuria. Seven days later a thin rancid discharge escaped from the umbilical crevice and all symptoms slowly subsided. Since then he has been conscious of a "soreness in the periumbilical tissues." Pressure of his belt, forced expirations, or the act of defecation usually provoked sharp twinges of umbilical pain.

Ten days ago he complained of generalized abdominal cramps which seemed to originate at the umbilicus. A hard, firm, tender mass appeared in the subumbilical region. The slightest pressure on this tumor elicited severe pains. He was unable to endure the irritation of his clothing, and the act of walking, coughing and sneezing became unbearable. When recumbent, his thighs were flexed on his abdomen in order to lessen the tension of the recti muscles. Three days later the umbilicus suddenly became swollen, red and hyperemic. A few drops of white creamy pus escaped from the umbilical groove, smears and cultures of which revealed the presence of a mixed streptococcal and staphylococcal infection.

Hot fomentations, antiseptic irrigations and repeated dilations of the umbilical orifice were all ineffective. The inflammatory induration spread downwards toward the bladder causing a marked dysuria, but again neither pus nor bacteria could be demonstrated in the urine. As the pyogenic process followed the round ligament up toward the liver, he developed paroxysms of nausea and vomiting. His temperature rose to 101.8° F. and his leukocytes increased to 18,600. All the muscles of the anterior abdominal wall were so tender and spastic that no intra-abdominal tumor could be felt.

Failure to respond to conservative treatment caused considerable alarm for it indicated the presence of some coexisting complication. The extension of the suppurative process toward the bladder and the presence of a dysuria suggested the possibility of an infected urachal cyst or a patent urachus. Hoping, therefore, to visualize the cyst, 10 cc

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of lipiodine were injected into the umbilical crevice. The contrast medium followed along the umbilical groove, penetrated the linea alba and entered a large "intra-abdominal pocket." This cystic cavity extended downward to within 3 cm. of the bladder, but none of the opaque medium entered this viscus. Aniline dyes which were introduced into the umbilical sinus did not appear in the urine, hence disproving the presence of a patent urachus. Thinking that this was a urachal cyst which might rupture spontaneously, an exploratory laparotomy was advised.

Under ether anesthesia, the abdomen was opened by a left rectus incision in order to examine the peritoneal surface of the umbilicus without disturbing the cyst. A large fluctuant tumor mass was found attached to the peritoneum of the anterior abdominal

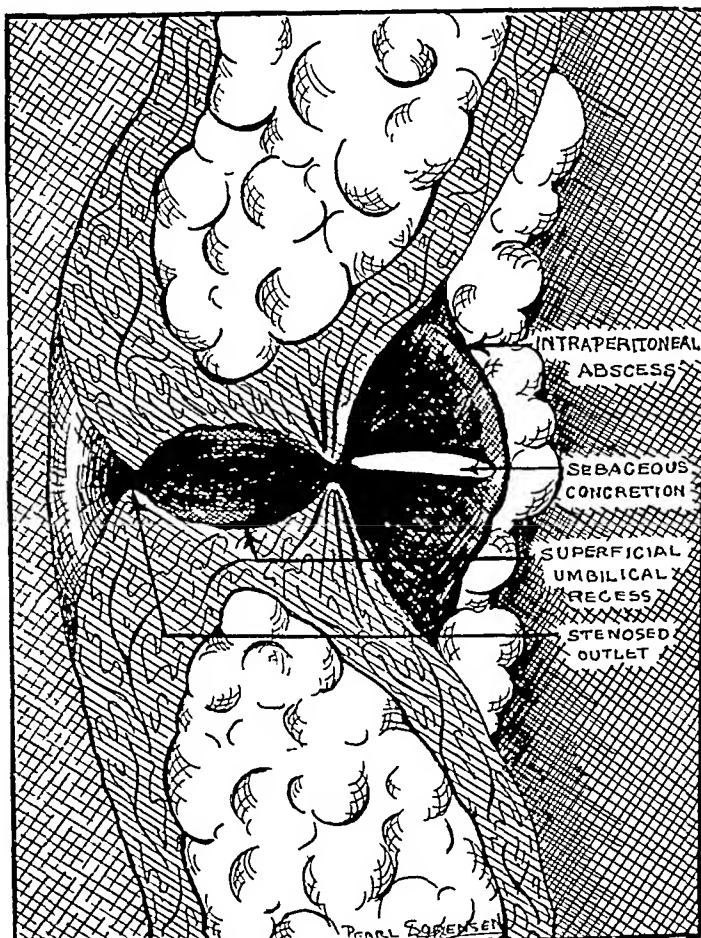


FIG. 1—A drawing representing an intraperitoneal abscess formed by the spontaneous rupture of an umbilical abscess with extrusion of a sebaceous concretion into the peritoneal cavity.

wall. It extended from the umbilicus to within 3 cm. of the dome of the bladder and upward along the falciform ligament to the lower border of the liver. This hyperemic, inflammatory but cystic tumor measured two and one-half inches in diameter and five inches in length. Careful examination revealed that this was not a true urachal cyst but rather an intra-abdominal abscess which had become walled off by the thick edematous omentum. Realizing that the infection originated in the umbilicus and involved the anterior abdominal wall, it seemed advisable to excise all the diseased tissue. This was accomplished without rupturing the abscess but necessitated the removal of a large segment of the abdominal wall. In spite of all these precautions he developed a generalized peritonitis which resulted in a stormy convalescence from which he made an eventual recovery.

*Pathologic Examination*—The specimen consisted of the umbilicus and the surrounding segment of the anterior abdominal wall. The umbilical cushion was so swollen, indurated and edematous that it practically occluded the external orifice of the umbilicus (Fig 1). Extending from the stenosed cutaneous opening to the linea alba was a slightly dilated umbilical tract which formed a definite loculated recess lined with ulcerated epithelial tissue. Coursing along the side of the cicatrized remnants of the umbilical cord was a small patulous fistula which connected the superficial umbilical recess with a large subumbilical intraperitoneal abscess. The latter measured two and one-half inches in diameter and four inches in length and was formed by the peritoneum anteriorly and by the omentum in all other directions. Slight pressure on the intra-abdominal abscess caused thick, foul smelling pus, loaded with flaky desquamated material, to escape from the cutaneous umbilical opening. On incising this loculated abscess, it was found to contain three ounces of pus in which a yellowish white, cigarette shaped, glistening object was floating. This foreign body was 1.5 cm long and 5 cm in diameter and had the consistency of soft paraffin. It was somewhat compressible and was composed of an homogenous cheesy matrix containing exfoliated epithelial cells, small fragments of cotton threads, and few short strands of hair. Gentle pressure on the large abscess caused this concretion to pass through the small fistulous tract into the superficial umbilical recess. Extending downward from the umbilicus toward the bladder was a firm, inflammatory intumescence which was confined to the properitoneal space, thus being extraperitoneal. Repeated gross and microscopic examinations failed to show any evidence of an urachal cyst or a vestige of the urachus but merely indicated an acute inflammatory reaction of the properitoneal fat. A similar inflammatory process followed the round ligament up toward the liver, this, too, being extraperitoneal. The restraining abscess wall consisted of omentum and was not lined with either endothelial or epithelial tissues.

The probable sequence of events is as follows. The cicatricial stenosis of the external umbilical orifice caused a retention of sebum and desquamated epithelial cells. These products, combined with small fibers of cloth from the clothing and a few strands of hair, formed an inspissated concretion which irritated the epithelial lining of the umbilical tract, thus resulting in ulceration, infection and abscess formation. Being unable to escape, the accumulated pus dissected its way along the umbilical cord until it finally ruptured into the peritoneal cavity, thus permitting both the pus and the concretion to escape into the abdomen. The alert omentum prevented a generalized peritonitis from occurring by localizing the infection. Simultaneously the inflammatory process invaded the properitoneal space, first following the obliterated hypogastric vessels and the fibrous urachus downward toward the bladder and likewise dissecting its way along the falciform ligament toward the liver. Our inability to demonstrate a patent urachus or to find any histologic evidence of a cyst wall, combined with the fact that the falciform ligament was involved in the same inflammatory process, negates the probability of this being an infected urachal cyst. Apparently the sebaceous plug had penetrated the anterior abdominal wall and was responsible for this unusual catastrophe.

In a rather careful search of the literature we were unable to find a similar instance of an umbilical concretion spontaneously perforating the linea alba and forming an intra-abdominal abscess. The nearest analogy to this was

the cases of ruptured urachal cyst and pyourachus reported by Lazarus and Rosenthal<sup>18</sup> and by Deneen and Margold<sup>9</sup>. In these cases they experienced no difficulty in demonstrating the presence of a patent urachus.

#### RECURRING UMBILICAL CHOLESTEATOMA ASSOCIATED WITH A PYOUMBILICUS

**Case 2**—Miss A. N., school teacher, age 24, entered the hospital complaining of a "painful navel." When six months old, her umbilicus became red, swollen and tender, and emitted a foul, rancid discharge for a period of three weeks. Since then she has had five similar attacks, the most severe one occurring five years ago, when she complained of epigastric distress, periumbilical pain, and pronounced abdominal tenderness. A thick, creamy pus escaped from an irritated and inflamed umbilical crater. Gentle dilatation of the external orifice, combined with antiseptic irrigations, caused the inflammation to subside and permitted the spontaneous extrusion of a small "bean-shaped" object. It was covered with a white glistening "membrane" and was composed of a thick, cheesy, sebaceous material containing a central plug of hair. Her Parisian physicians thought it to be an expelled sebaceous cyst. All signs of inflammation immediately subsided.

There were no exacerbations until three days ago when she felt a sharp twinge of periumphalic pain. Walking, riding, sneezing, coughing or localized pressure increased the discomfort. Two days later, a thin, purulent, malodorous discharge escaped from the umbilical depression and caused an excoriation of the surrounding skin. Anorexia, nausea and malaise were concomitant.

Examination revealed an angry, red umbilicus emitting a thin streptococcal laden pus. The umbilical cushion was so swollen and edematous that it practically occluded the umbilical orifice. Attempts to pass a small probe elicited severe pain. The inflammatory process had spread to the periumbilical tissues for a radius of 3 cm., forming a hard, indurated, tender tumor of the anterior abdominal wall. No suprapubic tenderness could be demonstrated. The urine did not contain pus and dyes injected into the sinus tract did not discolor the urine. Roentgenographic visualizations of the umbilicus following the introduction of lipiodine demonstrated that the umbilical groove was definitely dilated but that it was not patent beyond the linea alba, being obliterated by the umbilical cicatrix. No evidence of a patent urachus or intra-abdominal abscess was seen but a negative shadow indicated the presence of a retained concretion.

Following the application of hot packs to the umbilicus, two ounces of thick pus escaped. Then the cutaneous stoma was gently dilated and a firm, white ovoid body was expressed. This mass measured  $\frac{3}{4}$  cm. in diameter and 2 cm. in length and was covered by a shining pseudomembrane which proved to be nothing more than inspissated sebum. The central core consisted of three strands of hair and two small fibers of cloth which were imbedded in a homogenous matrix of rancid sebum. Ten days later, after all signs of infection had subsided, the umbilicus was excised in order to prevent a recurrent omphalitis.

The specimen consisted of a dilated umbilical pouch, having a diameter of 2 cm. and a depth of 5 cm. The external stoma was very small, being practically occluded by the hypertrophied umbilical cushion, and the inner end terminated blindly in the cicatrix just before the cord penetrated the linea alba. The epithelial covering of the cavity was ulcerated and studded with multiple abscesses. Microscopically, the tissues merely evidenced an acute inflammatory reaction and no signs of a patent urachus could be found.

The interesting phase of this case was the pernicious tendency for omphalitis to recur and the formation of two distinct sebaceous plugs, both of which were extruded spontaneously. Apparently the anatomic conformation of the umbilicus was such that the narrowed cutaneous stoma favored the accumulation of sebum and desquamated epithelial cells resulting in the formation of

sebaceous cholesteatomata. Emphasis should be placed on the futility of treating these recurring pyogenic infections of the umbilicus without attempting to correct the predisposing anatomic factor. Had the umbilicus been removed following the extrusion of the first concretion, or if the external ostium had been kept widely dilated, the subsequent infections would not have occurred.

CONCRETION ASSOCIATED WITH PYOGENIC GRANULOMA OF THE UMBILICUS

Case 3—Mr. R. C., age 42, came to the dispensary complaining of a "boil in the belly button." Four years ago he developed a frank hematuria. Cystoscopic examination revealed two pedunculated papillomata arising from the dome of the bladder. They were removed by transurethral fulguration and histologic studies demonstrated the



FIG. 2.—Pyogenic granuloma of the umbilicus, secondary to a retained umbilical concretion.

presence of an adenopapillary carcinoma. He was then given a course of intensive roentgen therapy. All symptoms disappeared until two years later, at which time he again complained of a dysuria associated with a hematuria. Examinations showed that the entire dome of the bladder was involved in an infiltrating, papillomatous type of tumor. This neoplastic segment of the bladder was resected and complementary roentgen therapy was given. He made excellent progress until three months ago at which time he again voided some bright red blood. Thinking that his problem was hopeless he neglected to return to the hospital.

Ten days ago he first experienced a rather sharp, persistent pain about the umbilicus and on examining himself he found a hard, indurated periumbilical swelling. This tumor mass rapidly increased in size and as it protruded from the umbilical crater it resembled a large boil. Three days later the "boil" ruptured and thick, malodorous discharge escaped. This afforded partial relief but the persistent soreness and pain continued. He was nauseated and experienced alternating sensations of "fever and chills." The hematuria became very pronounced but no trace of blood or urine could be detected in the umbilical secretion. Gram-positive Diplococci and Staphylococcus aureus were grown from the extruded pus.

On examination, the periumbilical structures were found to be hyperemic, swollen and indurated. The tissues in the suprapubic area were sensitive to the slightest touch and moderate pressure elicited intense pain. No suprapubic tumor could be defined and while manipulation of these inflamed tissues gave the patient an intense desire to void, it did not increase the discharge from the umbilical fistula. Arising from the upper half of the umbilical cushion was a walnut sized tumor having a deep red color. It was exquisitely tender and seemed to completely block the cutaneous outlet of the umbilical crevice (Fig 2). Attempts to pass a fine wire probe through the stenosed opening elicited severe pain but resulted in the evacuation of a few drops of thick pus. Cystoscopic examination demonstrated two large papillomatous recurrences with marked infiltration and roughening of the entire upper three-fourths of the bladder. This malignant lesion encroached on the ureteral orifices in such a manner as to render excision impos-

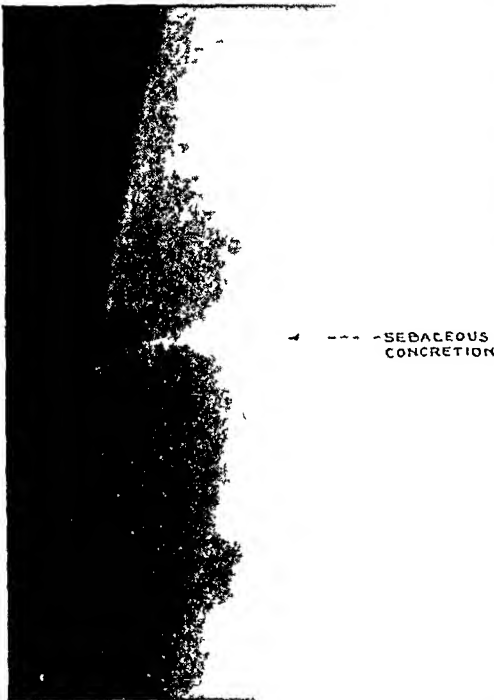


FIG 3—Roentgenographic visualization of the offending umbilical concretion by injection of  $1\frac{1}{2}$  cc of thorotrast into the umbilical crevice

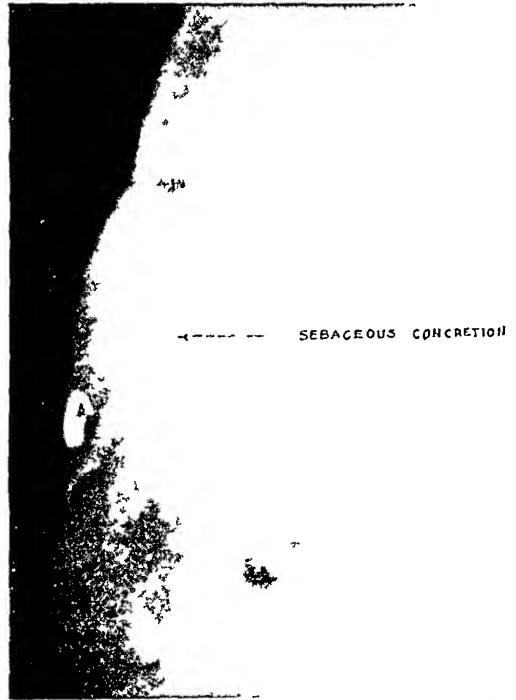


FIG 4—Two cubic centimeters of thorotrast outline the dilated superficial recess and demonstrate the sebaceous concretion

sible. No evidence of a urachus could be seen and dyes which were injected into the umbilical sinus did not discolor the urine.

Hot fomentations and antiseptic irrigations facilitated the drainage of the periumphalic abscess but it did not cause a decrease in the size of the umbilical tumor. Because of its refractory nature it was thought that this neoplasm might be a carcinomatous transplant from the bladder, the malignant cells having traversed a patent urachus. Therefore, a biopsy was advised. After anesthetizing the umbilicus it was forcibly dilated and a half ounce of pus and desquamated material was expressed. Thereupon, 5 cc of lipiodine were introduced into the umbilical sinus. A roentgenogram demonstrated that the contrast medium had completely filled the dilated superficial umbilical recess. This "dilated pouch" extended from the skin to the linea alba and measured 2.5 cm by 5 cm. No evidence of a patent urachus or a urachal cyst could be found. In the center of the dilated umbilical tract was a "negative shadow" which indicated that some solid substance had replaced the thorotrast (Fig 3). On introducing a hemostat into the superficial umbilical recess, a definite obstruction was encountered and on attempting to remove this "impediment," eight fragments of a sour rancid sebaceous plug were extracted. A portion of the tumor was then excised. Histologic studies of this tissue

demonstrated a simple pyogenic infection of the umbilical tract without evidence of malignant changes. The inflammatory reaction immediately subsided and the patient left the hospital as he refused treatment for the bladder neoplasm.

#### CHRONIC PYOUMBILICUS WHICH HAD DRAINED FOR A PERIOD OF 21 YEARS DUE TO RETAINED CONCRETIONS

**Case 4**—Mrs L. L., housewife, age 50, was admitted to the hospital because of heart trouble, diabetes and an "infected navel." Since the birth of her first child, 21 years ago, she has had a persistent drainage from the umbilicus. At times the circumumbilical tissues would become sore, swollen, tender and painful. Then a rather thick offensive fluid seeped from the umbilical groove. The escape of this material was always followed by a cessation of the pain and discomfort. At times the purulent discharge became so repulsive that she resorted to frequent irrigations in order to overcome the unpleasant odor. Two weeks ago the umbilicus became very painful, tender and was extremely sensitive to pressure. Three days later a foul malodorous discharge escaped from the umbilical crevice and since then there has been a persistent drainage.

Examination demonstrated a funnel shaped umbilicus having a firm, indurated, protruding umbilical cushion. The stoma was so narrow that it would not admit a small wire probe, and any attempt to dilate the orifice caused pain. Pressure on the peri-umbilical tissues expressed some thick, rancid pus which contained numerous *Staphylococci*. There was no tenderness over the liver or urachal areas.

Conservative treatment in the form of hot moist packs and antiseptic irrigations caused much of the induration to subside. Thorotrast was then injected into the umbilical sinus. The contrast medium formed a V shaped outline signifying the presence of a superficial dilated umbilical tract. The central part of the tract gave a suggestive negative shadow indicating the presence of a foreign body (Fig 4). The region was anesthetized and the orifice was dilated. A bean shaped plug of sebum was expressed from the umbilicus, following which some flaky foul smelling pus escaped. Continued irrigations and fomentations resulted in a rapid subsidence of the inflammatory reaction. Two weeks later the superficial umbilical tract was excised and was found to extend down to the sheath of the linea alba. It consisted of a dilated pouch measuring 2 cm in width and 4 cm in depth. Its epithelial lining was ulcerated and inflamed and there were considerable fibrosis and lymphocytic infiltration of its walls. No evidence of a sebaceous cyst, patent urachus or persistent omphalomesenteric duct could be found. The wound healed by primary intention.

**DISCUSSION**—Interestingly each of these four cases was associated with umbilical concretions which were directly responsible for the omphalitis. Careful examination of the excised specimens indicates that there was one characteristic anatomic defect which was responsible for the formation of these concretions, namely, a stenosis or narrowing of the cutaneous umbilical orifice. When it is remembered that the umbilical tract is lined with epithelial tissue it becomes apparent that there is a constant production of sebaceous secretions, and desquamation of hair and epithelial cells. Normally, these products pass out through the gaping umbilical orifice but if the cutaneous ostium is obstructed, then these substances accumulate and form a concretion. In these cases the obstruction was caused by a fibrotic stenosis of the cutaneous ring. The external umbilical stomata were so narrowed that they would barely admit a small wire probe. Occasionally a tumor such as a fibroma,<sup>4</sup> myxoma,<sup>22</sup> dermoid cyst,<sup>17</sup> or pyogenic granuloma may occlude the umbilical groove. As the concretion becomes larger, it begins to irritate the

epithelial lining, resulting in a pressure necrosis, infection and finally abscess formation

The majority of concretions are composed of an homogenous sebaceous matrix which contains desquamated epithelial cells, strands of hair<sup>24</sup> and a few fibers of cloth. However, other extraneous material such as dirt,<sup>14</sup> coal,<sup>14</sup> stone, chalk,<sup>19</sup> hair balls,<sup>21</sup> flannel fibers from a belt,<sup>28</sup> wild oat straws,<sup>10</sup> and maggots<sup>12</sup> have formed the central nidus of such concretions. As the sebaceous plug grows it also becomes dehydrated for the moisture is absorbed by the adjacent tissues. Thus the inspissated sebaceous body may form a hard, cornified plug which may protrude from the umbilicus or it may become so hard and pearly like that it resembles a cholesteatoma. To these latter Coenen<sup>6</sup> has applied the term "umbilical cholesteatoma" because of their close similarity to the aural cholesteatoma.

Uncleanliness in the care of the umbilicus is often given as predisposing toward the formation of concretions. This is not absolutely true, as each of our patients had excellent habits of personal hygiene and had paid particular attention to the cleansing of the umbilicus. Hence, the collection of the sebum was not due to faulty care, but due to the fact that the stenosed cutaneous opening was so small that they could not properly remove the accumulated cellular detritus.

The preoperative diagnosis of a pyoumbilicus secondary to retained concretions is seldom made. This is due to the fact that suppurative omphalitis is so frequently associated with other causes. The failure to recognize an incarcerated sebaceous plug or cholesteatoma occasionally accounts for some cases of recurrent periumphalitis. At the time of examination, the umbilical tissues are so sore and tender that one cannot feel the concretion, and the ostium is so small that the plug of sebum cannot be felt with an instrument. Hence the only manner of recognizing these concretions is to resort to roentgenographic visualization. The use of such substances as lipiodine and thorotrast clearly depicts the location and size of the foreign bodies and thus facilitates their removal. Likewise, these roentgenograms visualize associated complications such as an intra-abdominal abscess, a coexisting patent urachus, a urachal cyst, or a subumbilical abscess. We did not surmise the presence of the intra-abdominal abscess in the first case until the visualization studies were made.

Omphalitis with or without associated discharge presents a very difficult diagnostic problem, as it is usually secondary to other pathologic changes. When it is remembered that the umbilicus is the thinnest part of the abdominal wall, one appreciates why so many suppurative lesions choose this exit for their drainage course. The literature contains numerous examples in which an umbilical fistula may result from the spontaneous rupture of a periprostatic,<sup>23</sup> pelvic,<sup>11</sup> appendiceal<sup>13</sup> or liver abscesses<sup>3</sup>, or it may be associated with a pneumococcal,<sup>5</sup> tuberculous<sup>2</sup> or other form of pyogenic peritonitis.<sup>27</sup> The contents of a patent<sup>15</sup> or malignant<sup>7</sup> urachus or of an infected urachal cyst may escape via the umbilicus. Likewise, a purulent navel discharge may be caused by a suppurative ovarian cyst<sup>25, 26</sup> or a degenerating carcinoma of



the ovary<sup>1</sup> Intra-abdominal abscesses secondary to perforation of the intestines resulting from a mesenteric thrombosis or from a strangulated hernia<sup>21</sup> may evacuate their contents through the umbilical ostium Gallstones<sup>20</sup> and bile have both been extruded from the umbilical tract Suppurative omphalitis<sup>16</sup> is rather common in infancy and may be due to a localized infection of the umbilical cord, to a persistent omphalomesenteric duct<sup>15</sup> or to a patent urachus<sup>15</sup> Even empyemic cavities<sup>8</sup> resulting from a pneumonitis have perforated the diaphragm and poured their purulent contents through the umbilicus Hence, a suppurative omphalitis is a serious condition and is usually associated with some grave abnormality To consider them as mild superficial infections is to invite trouble Recognition and correction of the underlying pathogenic factors are absolutely necessary if a cure is to be effected

Before resorting to extensive surgical procedures the acute infection can usually be controlled by conservative measures Absolute bed rest is essential, for it prevents continued irritation Hot fomentations, antiseptic irrigations and gentle but persistent dilatation of the external umbilical orifice permit the pus to escape and the infection subsides Not infrequently, the fistulous tract will evacuate a distended urachal cyst or drain the intra-abdominal abscess and also permit the concretion to escape, thus facilitating the later excision of the abnormal sinus If there are no associated complications, one should never be satisfied with the mere extraction of the sebaceous plug While such a procedure temporarily controls the inflammatory process, it does not prevent future recurrences Even though widely dilated, the umbilical orifice again becomes stenosed and a reaccumulation of the cellular debris and secretions results in the formation of another concretion It seems prudent, therefore, to excise the dilated umbilical tract during this period of quiescence Women sometimes object to having the entire umbilicus excised because of the resulting deformity In such instances, the umbilical cushion can be preserved as this gives the necessary "midline dimple," but the umbilical tract must be removed

#### CONCLUSIONS

(1) In each of the four cases presented, the suppurative omphalitis was directly caused by the irritating effects of retained umbilical concretions

(2) Stenosis or narrowing of the external umbilical orifice predisposes to the accumulation of sebaceous materials, desquamated epithelial cells, hair, and fibers of cloth which form these "umbilical concretions"

(3) These umbilical abscesses may drain externally or rupture intraperitoneally

(4) Roentgenographic studies are valuable, not only in demonstrating the location and extent of the lesion but they depict associated complications, such as the presence of umbilical concretions, patent urachus, urachal cysts, or persistent omphalomesenteric ducts

(5) Simple extraction of the sebaceous plug and antiseptic irrigations will usually control the infectious process but recurrences are almost inevitable, unless the dilated umbilical tract is excised

## REFERENCES

- <sup>1</sup> Aslanian, G Cited by Cullen, 428 Contribution a l'etude de la peritonite cancreuse These de Paris, No 150, obs 70, 1895
- <sup>2</sup> Baginsky Intestinal and Peritoneal Tuberculosis with Perforation and Formation of Fecal Reservoir Opening at the Umbilicus Zur Demonstration eines Propartes Verhandl d Berl med Gesellsch Jahrg, 11, 90, 1879-1880
- <sup>3</sup> Berard Quoted by Cullen, 297 Abscess of the Liver Opening at the Umbilicus
- <sup>4</sup> Bryant, T Fibroma Umbilicus Guy's Hospital Report, 9-245, 1863
- <sup>5</sup> Cameron, H C The Relative Value of Immediate and Delayed Laparotomy in Pneumococcal Peritonitis Proc Roy Soc Med, No 4, 5, 123, 1912
- <sup>6</sup> Coenen, H Ueber das Cholesteatoma des Nabels Beitr z klin Chir, 58, 718, 1909
- <sup>7</sup> Cullen, T S The Umbilicus and Its Diseases, 249 Philadelphia, W B Saunders Co, 1916
- <sup>8</sup> Curran Quoted by Cullen, 288 Empyema Draining at the Umbilicus
- <sup>9</sup> Deneen, E V, and Margold, A Ruptured Infected Urachal Cysts into the Peritoneal Cavity J Urol, 25, 457, 1931
- <sup>10</sup> Fabrege Note sur les excroissances, polypeuses de la fosse ombilicale chez les enfants nouveau-nés Rev med chir, 4, 353, 1848
- <sup>11</sup> Fereol Quoted by Cullen, 289 Broad Ligament Abscess Draining at the Umbilicus Quoted by Nicaise Ombilic Dictionnaire encyclopedique des sci med 2 ser, 15, 140 Paris, 1881
- <sup>12</sup> Fullerton, John S Quoted by Cullen, 260
- <sup>13</sup> Haggard, W D Quoted by Cullen, 305 General Peritonitis Cured by Incision and Drainage of Protruding Umbilicus, Cause Ruptured Appendix
- <sup>14</sup> Hahn, Otto Ein Nabel konkrement von Taubeneigrosse Beitr z klin Chir, 26, 80 1900 Chirurgische Erkrankungen des Nabels Deutsche Ztschr f Chir, 456, 1890 Nicaise Ombilic Dictionnaire encyclopedique des sci med 15 ser, 2, 140 Paris, 1881
- <sup>15</sup> Heflin, H T Quoted by Cullen, 492 A Patent Urachus and a Patent Omphalo-mesenteric Duct in the Same Child
- <sup>16</sup> Holt, E L, and McIntosh, R Holt's Diseases of Infancy and Childhood Appleton, New York, 10th Ed, 1932
- <sup>17</sup> Hue, F Kyste dermoide de l'ombilic Rev de cir, 3, 193, 1883
- <sup>18</sup> Lazarus, Joseph, and Rosenthal, A A Ruptured Pyourachus Complicated by Urethral Stricture ANNALS OF SURGERY, 102, 49-54, 1935
- <sup>19</sup> Ledderhose, G Chirurgische Erkrankungen des Nabels Deutsche Ztschr f Chir, 45b, 1890
- <sup>20</sup> Leguelinel de Lignerolles Quelques recherches sur la region de L'ombilic et les fistules hepaticques ombilicales These de Paris, No 6, obs 1, 1869
- <sup>21</sup> Martin, M E Abces de l'ombilic, gangrene, et perforations intestinales, peritonite generalisee, mort Bull de la Soc Anat de Paris, 47, 148, 1872
- <sup>22</sup> Mori, A Contributo allo studio dei tumori ombelicali Gazz d osp, 23, 632 Milano, 1902
- <sup>23</sup> Nicaise Quoted by Cullen, 288 Periprostatic Abscess Opening at the Umbilicus
- <sup>24</sup> Pernice, L Quoted by Cullen Die Nabelgeschwulste
- <sup>25</sup> Roques Kyste occasionne par la presence d'un fragment de terre dans l'ombilic Gaz d hop, 314, 1862
- <sup>26</sup> Trepan Quoted by Cullen, 307 Kyste de l'ovarie, inflammation des parois et issue des membranes par l'ouverture ombilicale, guerison
- <sup>27</sup> Vaussy, F Des phlegmonons sous-peritoneaux de la paroi abdominale anterieure These de Paris, No 445, 1875
- <sup>28</sup> Walters, F R Umbilical Pocket Brit M J, 1, 173, 1893

# FEMORAL HERNIA IN THE MALE

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FEMORAL hernia in the male is a relatively uncommon condition as compared with inguinal hernia. Two thousand sixty-one inguinal herniae have been repaired at the U S Marine Hospital, Staten Island, N Y, during the past six years as compared to 63 femoral herniae. This gives a relative frequency of 1 to 44. Thirty-five occurred on the right side and 28 on the left. There were five patients with bilateral femoral herniae.

Of these 63 femoral herniae 62 per cent were in men past the age of 40. The ages of patients with femoral hernia in this series are seen in Table I.

TABLE I  
AGE INCIDENCE

3	20 to 30 yrs
21	31 to 40 yrs
26	41 to 50 yrs
10	51 to 60 yrs
2	61 to 70 yrs
1	above 70 yrs

A femoral hernia in its descent passes downward through the femoral ring. Beyond this ring the sac dilates and becomes globular or egg shaped and seldom descends more than two inches before treatment is necessary. As the sac enlarges it passes downward through the femoral canal and then pushes superficially through the saphenous opening, presenting beneath the skin of the thigh just below Poupart's ligament.

The neck of the sac is bounded above by Poupart's ligament, laterally by the femoral vein and medially by Gimbernat's ligament. Variations in the method of presentation of the sac include pectineal, multidiverticular, prevascular, and hernia occurring through Gimbernat's ligament. The latter two are rare. In the prevascular type the sac passes in front of the femoral vessels. While the neck of the usual femoral hernia seldom is over 1 cm in diameter, the neck of the prevascular type may be sufficiently large to admit two or three fingers.

The origin of the femoral sac is uncertain. The majority of text-books state that it is a preformed sac, but give no reasons for such a statement. The following facts would seem to indicate that the femoral sac is not preformed but that it is a developmental condition of later life. If it was a preformed sac as many assert, as in indirect inguinal hernia, the age of occurrence would be expected to be at an age comparable to that of the occurrence

of indirect inguinal hernia. Femoral herniae are rarely seen in children and in this series of cases only 4 per cent occurred before the age of 30 years. Sixty-two per cent occurred after the age of 40. If the femoral sac was preformed it would be expected to make its presence known frequently before the age of 20 and in the majority of instances before the age of 40.

A direct hernia is an acquired defect. It is the result of a continued or repeated strain at the site of a congenitally or acquired weakened inguinal region. Direct hernia occurs almost entirely in adults. In male children under 15 years of age direct hernia is a rarity. The same may be said for femoral hernia. Coley states, "The age of most frequent occurrence of direct hernia is between 30 and 40 years, seldom before 20." The same may be said for femoral hernia, with the addition that it is seldom seen before 30.

The indirect inguinal sac is conceded to be a preformed sac. Gray's Anatomy states that at the seventh month of fetal life a blind pouch or diverticulum forms. The testes enter this diverticulum and descend within it into the scrotum. At a later stage the connection between the tunica vaginalis and the abdominal cavity is usually obliterated. There remains, however, this preformed sac at the internal ring which may increase in size with time. It is a normal developmental condition.

In the direct hernia there is no preformed sac since there is no developmental change such as occurs in the descent of the testicle at the site of the indirect sac. Likewise the femoral region has no such developmental process. The nerve and iliac vessels are entirely extraperitoneal. In their development there is no firm adherence and no evident tension on the femoral peritoneum. If there were, the femoral sac should appear in childhood and early adult life.

I have made it a practice when performing an inguinal herniotomy to inspect the femoral region with my fingers in the abdomen through the opened indirect sac. In the young adult I do not find any relaxation about the femoral region. In older adults, not infrequently, however, with the relaxation of the abdominal wall and the formation of a direct sac, there is found a slight depression in the femoral region. This is an acquired condition just as is the direct sac. The facts as given above would seem to indicate that the majority of femoral herniae are not preformed.

Clinically, femoral herniae apparently give symptoms much earlier than do indirect and direct inguinal herniae. The symptoms may be at once pronounced so that the patient seeks relief by operation very soon after the hernia makes its appearance. In this series 89 per cent came for relief within one year after the symptoms began. Twenty-one per cent required relief within one month after the onset of symptoms. This differs from the usual inguinal hernia which may cause little discomfort for a long period after being noted. In femoral hernia strangulation may occur early. Three such cases were admitted with a strangulated loop of intestine. It is very common in opening a femoral sac to find a piece of incarcerated omentum. In two cases a Richter's hernia was found. In one the appendix was found in the femoral sac.

The only satisfactory method of treatment is surgical. The inguinal route is preferred for repair of all femoral herniae. Forty-two of the 63 cases reported here were repaired by the inguinal route. The majority of those not repaired by this method were operated upon previous to two years ago. During the past two years only four cases have been repaired by the usual femoral route. Two of these had previously had an inguinal hernia repair on that side which was sound. The other two had unusually sound inguinal regions.

The inguinal incision is preferred for two reasons. First, because it is possible to make a very much better repair, and second, it is very much safer to inspect the femoral opening from the intra-abdominal side before opening the femoral sac, than to try to incise and suture a fatty femoral sac which frequently contains incarcerated omentum and may contain an adherent or partially incarcerated Richter's hernia.

*Operative Technic*—An incision is made in the inguinal region through the skin, fat and superficial fascia just as if an inguinal hernia was to be repaired. The external oblique aponeurosis is incised upward from the external inguinal ring and the cord isolated and retracted. Unless there is a well developed indirect inguinal sac in addition which requires opening, and there seldom is, a pouch of peritoneum at the internal inguinal ring is searched for and opened. In 1,955 inguinal herniae upon which I have operated during the past five years, many of which had been diagnosed direct herniae, I have never seen a patient in whom I could not find a slight bulging or protrusion of the peritoneum at the internal inguinal ring. By gentle traction the peritoneum at the site of the internal inguinal ring can be made into a sac one-half inch to one inch in size. The thin peritoneum can be incised without danger of injury to any abdominal viscera. A finger is inserted and the femoral opening is explored from within the abdomen. If a loop of intestine is adherent or a Richter's hernia is present, it is recognized at once. Omentum can be removed if it is not adherent and the size and extent of the femoral sac determined. In many cases the femoral opening can be inspected by placing a small retractor in the peritoneal opening at the internal inguinal ring. There is by this method no danger of injury to viscera as in the usual femoral repair.

The inguinal incision is retracted so that the femoral canal is exposed, the femoral sac is now isolated below Poupart's ligament in the femoral canal. The neck of the sac is transfixed, ligated and the sac removed. With a finger in the peritoneal opening at the indirect inguinal ring, it is placed against the ligated stump of the femoral sac. The needle still attached to the femoral sac ligature is passed through the ligated stump in the femoral canal below Poupart's ligament against the tip of the finger, into the peritoneal cavity. As the finger is withdrawn from the internal inguinal ring, the needle follows it until the tip can be picked up with a forceps through the peritoneal opening. It is passed through the inguinal peritoneal sac and the needle is removed. The other end of the femoral sac ligature is similarly manipulated except that it is brought out on the opposite side of the peritoneal opening.

at the internal ring. They are then drawn upon and tied. This closes the peritoneal opening and brings the ligatured femoral stump and inguinal peritoneal sac together. The femoral stump, instead of remaining a funnel shaped protrusion, now has its apex pointing upward far inside the femoral ring. The congenital weakness of the peritoneum at the internal inguinal ring has been corrected. With the finger introduced from below Poupart's ligament through the femoral opening the stump can now be felt far up in the abdominal cavity. There are those who believe that high ligation of the femoral sac is the only step necessary in the repair of femoral herniae. In all herniae repaired at this hospital the femoral canal is now closed with interrupted mattress sutures of silk which brings Poupart's ligament in apposition with the pectineal fascia at its insertion into the superior ramus of the pubis. There is no difficulty in retracting the inguinal incision so that the suturing to close the femoral canal may be accomplished with ease. The mattress sutures are tied on the inner or medial side of Poupart's ligament. The conjoint tendon is then sutured to Poupart's ligament with seven or eight interrupted silk sutures. The cord is placed in position and the external oblique aponeurosis closed with silk. This makes a safer and sounder femoral hernia repair and is the operation of choice.

If the patient is aged or a poor operative risk or if the inguinal region is unusually sound, the usual femoral repair using a femoral incision below Poupart's ligament is indicated. In the poor risk patient, where the time element may have to be considered, the femoral incision may be better as the entire operation can be performed in less than 15 minutes while the inguinal approach requires approximately twice that period of time.

In a few instances, usually seen in recurring inguinal herniae, as the result of too tight suturing or infection, there has been a destruction of Poupart's ligament with only a few strands of stretched out Poupart's ligament remaining. Under such conditions there is usually noted a direct bulge above Poupart's, or what remains of it, and a bulge below Poupart's ligament. It is really a combined direct inguinal and femoral hernia. A satisfactory femoral repair cannot be made with a destroyed Poupart's ligament. I do not agree that high ligation of a femoral sac is all that is necessary in the repair of a femoral hernia. The femoral opening must be closed. This requires a Poupart's ligament or one that can be reconstructed. For this very difficult type, which fortunately is seldom encountered, a satisfactory repair may be effected by transplanting the tensor fascia lata muscle with its investing fascia lata to repair the defect. The usual inguinal herniotomy incision is made and the femoral sac and the few remaining fibers of Poupart's ligament exposed. The femoral sac is ligated, removed and the stump transfixed to the indirect inguinal peritoneal sac as described above.

An incision is then made seven to eight inches long over the course of the tensor fascia lata muscle. The size of the flap of fascia lata beyond the termination of the muscle fibers is determined and the flap is raised. The sartorius muscle is separated from the rectus femoris muscle in its proximal

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three inches and the tensor fascia lata muscle is passed below it and transferred to the inguinal and femoral region

The flap is placed superficially to the remaining fibers of Poupart's ligament and is sutured securely with silk sutures to the superior ramus of the pubis. The sutures pass through the periosteum on the medial side of the ramus of the pubis, the insertion of the pectineus muscle and the transposed fascia lata. Relatively little tension is necessary as we are dealing with a live muscle with intact nerve and blood supply. By passing the fascia lata graft superficial to the remaining fibers of Poupart's ligament undue pressure on the femoral vein is avoided.

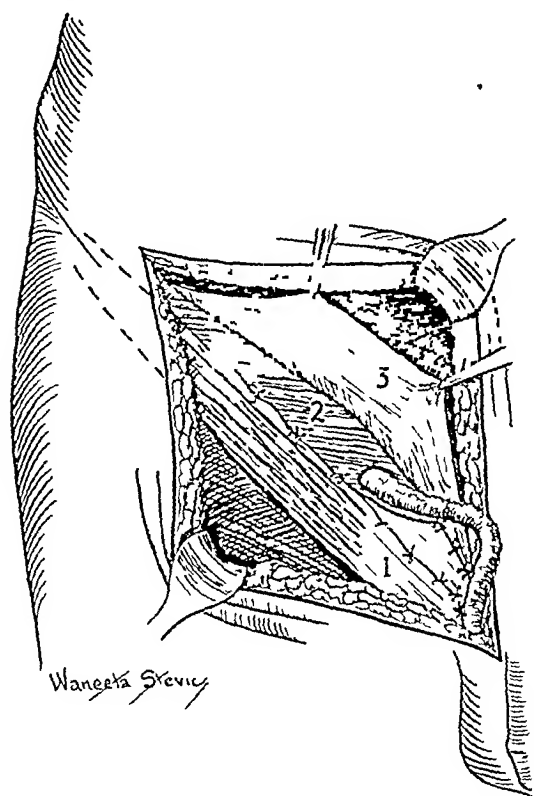


FIG 1—(1) Tensor fascia lata muscle transferred to the inguinal region. (2) The internal oblique and transversalis muscles are sutured to the tensor fascia lata muscle above the level of the internal inguinal ring. (3) The external oblique muscle retracted medially.

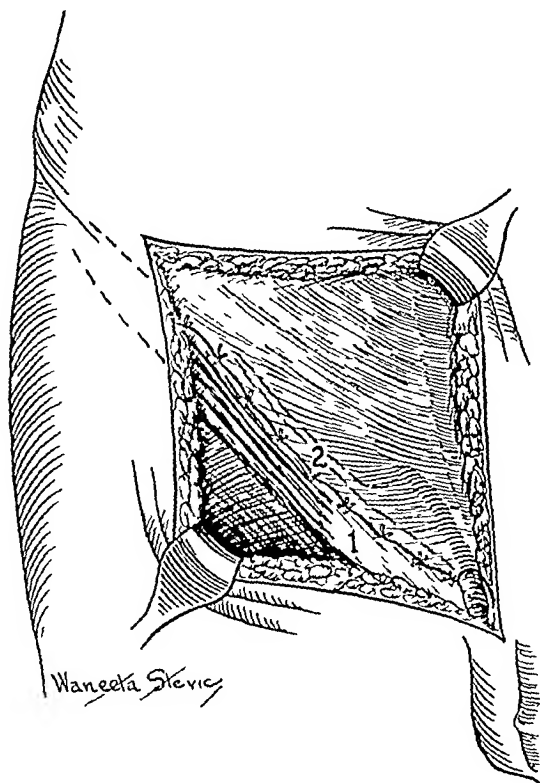


FIG 2—(1) The tensor fascia lata muscle has been sutured in place as described in Fig. 1. (2) The external oblique is brought down so that it overlaps the tensor fascia lata muscle and is sutured to it.

The newly constructed Poupart's ligament should be sutured to the superior ramus of the pubis as high up as the femoral vessels will permit, securely closing the femoral canal. The existing inguinal defect may be repaired by suturing the conjoint tendon to the fascia lata as it passes over the remains of Poupart's ligament (Fig. 1). The cord is placed in the inguinal canal. The external oblique aponeurosis is brought down over the flat surface of the tensor fascia lata and its enveloping fascia lata sheath and sutured in place with silk (Fig. 2).

In only two cases of femoral repair has this type of operation been required in the 63 cases. It does, however, offer a satisfactory method of repair in the unusual difficult femoral hernia in which there is an absence of a satisfactory Poupart's ligament.

## CASE REPORTS

**Case 1**—No 47710, was admitted to the hospital on July 2, 1934, for the repair of a recurrent hernia. He was 52 years old, and stated that he had had an inguinal hernia repaired in 1932. Two months later the hernia recurred. Examination showed a bulging in the inguinal and femoral regions apparently due to the loss of Poupart's ligament. He was operated upon on July 6, 1934. There was little of Poupart's ligament found. This allowed a protrusion into the femoral region and direct inguinal region. The tensor fascia lata muscle was transplanted to reconstruct Poupart's ligament as described above. Convalescence was uneventful although more prolonged than after a simple hernia repair. A period of 2½ months may be required before the postoperative discomfort has disappeared. Discomfort situated along the course of the tensor fascia lata muscle is the chief complaint. It is apparently due to the tension under which the tensor fascia lata is sutured.

The patient was instructed to return for an examination at intervals of 60 days. He has been examined on three occasions since the operation. The repair has remained sound. The last examination was approximately nine months following the operation.

**Case 2**—No 49795. A male, age 47, was admitted to the hospital for repair of a recurrent hernia. He had had a hernia repair in 1932. The hernia recurred in May, 1934. He was reoperated upon in July, 1934. The hernia recurred. At the time of examination there was a marked bulging into the direct inguinal region and into the femoral canal. A few strands of the remains of Poupart's ligament could be felt but it was markedly relaxed. He was operated upon February 18, 1935. At the time of operation a femoral and direct inguinal sac was found. There was little of Poupart's ligament remaining. The tensor fascia lata muscle was transplanted to reconstruct Poupart's ligament. Recovery was uneventful and he was discharged March 8, 1935. This patient returned for a follow up examination at two occasions at intervals of two months. The femoral region has remained firmly repaired. He was last examined in July, 1935.

## SUMMARY

Sixty-three femoral herniae are reported which have occurred in adult males during the past six years, as compared with 2,761 inguinal hernia repairs during that same period.

The femoral sac occurs usually after the age of forty. Evidence seems to prove that the usual femoral sac is not a preformed sac but is a developmental condition just as is the direct inguinal sac.

The inguinal route for repair of femoral hernia is the method of choice.

For those cases in which the femoral sac is a part of a general weakness due to loss of Poupart's ligament from previous herniorrhaphy and infection, the tensor fascia lata muscle used as a pedicled transplant offers a satisfactory method of repair.

## REFERENCES

- <sup>1</sup> Andrews, E. Closure of Large Femoral Defects. The Results of Destruction and Relaxation of Poupart's Ligament. *Surg., Gynec., and Obstet.*, 754, 1924.
- <sup>2</sup> Cattell, Richard B. Richter's Hernia. *Surg., Gynec., and Obstet.*, 700, March, 1933.
- <sup>3</sup> Consellor, V. S., and Cox, F. W. Strangulated Femoral Hernia. *Anatomy and Surgical Treatment*. *ANNALS OF SURGERY*, 717, May, 1933.
- <sup>4</sup> Coley, B. L. Three Thousand Consecutive Herniae with Special Reference to Recurrences. *ANNALS OF SURGERY*, 242, 1924.
- <sup>5</sup> Idem. The Radical Cure of Femoral Hernia. *ANNALS OF SURGERY*, 519, 1906.
- <sup>6</sup> Coopernail, G. P. Review of Operative Technique and New Method of Repair of Hernia. *Am Jour Surg.*, 458, December, 1933.



- <sup>7</sup> Easton, R Incidence of Femoral Hernia Following Repair of Inguinal Hernia J A M A , 1741, 1933
- <sup>8</sup> Foss, H L , and Hicken, N F Femoral Herniae Am Jour Surg , 349, September, 1922
- <sup>9</sup> Girotto, A Femoral Hernia Following Bassini Operation Riforma Med , 410, March 17, 1934
- <sup>10</sup> Johnson, A S Appendicitis in Femoral Sac with Adventitious Vascularization of Segregated Appendix Brit Jour Surg , 544, January, 1934
- <sup>11</sup> Keynes, G Prognosis of Femoral Herniae Lancet, 1406, December 22, 1934
- <sup>12</sup> Keynes, G Prevascular Femoral Hernia Brit Jour Surg , 55, July, 1932
- <sup>13</sup> LaRoque, G P Intra-abdominal Method of Removing Femoral Herniae Arch Surg , 189, February, 1932
- <sup>14</sup> Melville, R S Modification of Lotherson's Operation for Femoral Hernia Brit Med Jour , 467, March, 1935
- <sup>15</sup> Mayo, C W , and Phillips, J R Femoral Peritoneal Cyst Case Surg Clin N Amer , 1002, August, 1933
- <sup>16</sup> Payne, R L Operative Repair of Hernia by Living Fascial Sutures J A M A , 276, January 26, 1935
- <sup>17</sup> Shawan, H K , and Altman, R Femoral Hernia ANNALS OF SURGERY, 1270, May, 1935
- <sup>18</sup> Sweet, R H Incarceration of Meckel's Diverticulum in Femoral Hernia New England Jour Med , 997, May 22, 1930
- <sup>19</sup> Russell, R H Femoral Hernia, Principle and Procedure Surg , Gynec , and Obstet , 147, 1926
- <sup>20</sup> Wilson, G E Richter's Hernia—2 Cases J A M A , 1938, June 9, 1934
- <sup>21</sup> Lewis, Dean Practice of Surgery, Vol VII (W F Prior Co )
- <sup>22</sup> Nelson Loose Leaf Living Surgery, Vol IV (Thos Nelson and Sons )
- <sup>23</sup> Tasche, L W Etiology of Femoral Hernia Arch Surg , 749, October, 1932

# CERVICAL RIB AND THE SCALENUS ANTICUS SYNDROME

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MOVEMENTS of the head, neck, and shoulder girdle which produce undue pressure on the brachial plexus and subclavian vessels are followed in time by pain in the neck, arm, and hand, or by circulatory and trophic changes in the upper extremities. When a roentgenogram of the cervical portion of the spinal column reveals either unilateral or bilateral rudimentary cervical ribs, the diagnosis is indicated, but when the same symptoms are present and cervical ribs cannot be demonstrated, the clinical condition known as the "scalenus anticus syndrome" has been suggested.

Cervical ribs have been classified according to size into four groups. Their size, however, is no index to the severity of symptoms, as the determining factor is their relation to the adjacent structures, the most important of which is the scalenus anticus muscle. This muscle arises from the anterior tubercles of the transverse processes of the third to sixth cervical vertebrae and it is inserted into the scalene tubercle of the first rib. It is this muscle that compresses the subclavian artery and the brachial plexus against the cervical rib, it may also elevate the first rib, producing an abnormal lift to that rib, compressing the subclavian artery, and elevating and irritating the brachial plexus. This in turn causes spasm of the scalenus anticus muscle which is innervated by the irritated brachial plexus. Elevation of the shoulder girdle from this last named cause produces the same symptoms as do cervical ribs, and the condition has been designated by Ochsner and others as "the scalenus anticus syndrome."

Adson believes that the development of symptoms is attributable to two factors: (1) The muscular development of the young adult, whose bulging scalenus anticus muscle produces the symptoms, and (2) The sagging of the shoulder girdle of older persons, when there is an additional pull of the scalenus anticus muscle. According to Todd, compression of the subclavian structures results from abnormal development of the shoulder girdle. Normally, during intra-uterine and pre-adolescent development, the acromial end of the clavicle and the shoulder descend because of the weight of the upper extremity, and the sternal end of the clavicle descends because of contraction of the rectus abdominis muscle which is exerted through the sternum. No symptoms occur unless there is a greater than normal descent of the shoulder or an arrest of the descent of the sternum and the anterior ends of the ribs. Either one or both of these abnormalities

will result in compression of the subclavian structures because of stretching of the brachial plexus and the subclavian vessels over a fixed cervical or first thoracic rib. According to Jones, symptoms of cervical 11b are the result of an abnormal development of the brachial plexus. In cases in which the brachial plexus originates principally from the cervical segment of the spinal cord, no symptoms occur, whereas in those in which a considerable portion of the lower end of the brachial plexus is derived from the upper thoracic segments of the spinal cord, symptoms are likely to result from compression and angulation of the brachial plexus over the first rib or over cervical 11bs.

The symptoms of compression of the brachial plexus and subclavian artery are usually pain, atrophy, numbness, or circulatory changes consisting of cyanosis, ulcers, and rarely, gangrene. Pain may be sharp and lancinating, or only a dull ache may be present. Pain usually follows the course of the nerves leaving the lower part of the trunk at the brachial plexus, but occasionally it may extend upward to the shoulder and into the neck. The pain may be more or less continuous, but it is invariably exaggerated by rotation of the head or by a forceful downward pull of the shoulder. Quite frequently there is a history of pain following any sudden or violent exertion, and women usually complain of pain and numbness along the course of the ulnar nerve following difficult labor. Hyperesthesia, paresthesia and anesthesia may be associated with pain and it may persist after strenuous exertion. Atrophy occurs late and is rarely complete, it may be of two types, the median or partial thenar type, and the ulnar type. In the former type there is paralysis of the abductor pollicis and opponens pollicis muscles, which are supplied from the seventh cervical nerve, the remaining thenar muscles are intact. The flexor pollicis brevis muscle is also supplied by the median nerve, but probably from a different segment. The ulnar type of atrophy, in which there may be paralysis of all the muscles of the hands except the two just mentioned, is the result of injury by cervical 11b.

Circulatory symptoms are rarely severe, but they may manifest themselves in a dusky hue of the arm and hand as compared with the opposite upper extremity. There may be associated mild trophic changes in the tips of the fingers. Gangrene has been known to occur, involving one or more fingers, this usually is accompanied by obliteration of either the median or ulnar artery or both. Diminution in volume of the radial pulse is common, the pulse can be decreased or obliterated by having the patient elevate the chin or rotate the head to the affected side on inspiration. A diminution of the volume of the pulse on the affected side with a noticeable decrease of the surface temperature associated with numbness, coldness, and formication may be present. Ochsner found that the diminution in the volume of the pulse, as determined by oscillometer, is the most definite indication of the early vascular changes. Characteristically, the alteration of the oscillometric index, as determined by oscillograms, consists of a general decrease in the oscillations, particularly when the blood pressure reaches a high level. These symptoms vary in degree according to the amount of pressure over the subclavian

artery    Circulatory changes may be caused by constriction of the subclavian artery or subclavian vein, although Blair, Davies and McKissock agree with Telford and Stopford in the view that the changes are the result of irritation of the sympathetic fibers that pass to the distal arteries of the upper limb, and that they are not attributable to paralysis of sympathetic fibers. They based their opinion on the histologic examination of a brachial plexus in a case of cervical rib in which the vascular effects were pronounced.

The surgical indications for relief of symptoms of cervical ribs and for the relief of symptoms of the scalenus anticus syndrome are the same. As in other clinical conditions in which operation may offer relief, the severity of the symptoms enters into the surgical indications. A patient with mild symptoms and a low resistance to pain and discomfort usually is not as suitable for surgical treatment as one with more severe symptoms but who is stable.

Adson divided cases of cervical rib into three groups: (1) Those in which there is definite pain in the distribution of the brachial plexus but no circulatory disturbance and in which the patients are neurotic, (2) those in which symptoms are produced by anomalies in the supraclavicular triangle similar to those produced by cervical rib and the scalenus anticus syndrome, and (3) those in which definite symptoms are directly attributable to cervical rib. This last group he again divided into three subgroups: (a) Cases in which there is brachial pain with sensory or circulatory disturbances sufficient to incapacitate the patient, (b) cases of atrophy of the hand and arm on the affected side, and (c) cases of circulatory disturbance on the affected side without pain or atrophy sufficient to alter or obliterate the pulse on extension of the neck or rotation of the head. In the first group, operation is not in the majority of cases followed by satisfactory relief. In the second and third groups, however, the surgical treatment should be given careful consideration.

In a discussion of the scalenus anticus syndrome Ochsner emphasized the fact that there are certain clinical conditions which are likely to be confused, and that careful examination is necessary to rule out the possibility of cervical rib, subacromial bursitis, rupture of the supraspinatus tendon, cervicothoracic sympathalgia, Raynaud's disease, and brachial neuritis. However, the clinical picture of the scalenus anticus syndrome is identical with the foregoing symptoms of cervical rib.

The operation which has proved of greatest value for both cervical rib and the scalenus anticus syndrome is through the anterior approach described by Adson, which consists of an oblique incision about 5 cm. in length extending upward and backward from the sternoclavicular articulation into the posterior triangle. Dissection is then carried downward through the fat and platysma myoides muscle until the tendon of the sternocleidomastoid muscle and its attachment to the clavicle is exposed. This clavicular attachment is divided between two pairs of forceps, the muscle portion is then reflected mesially, exposing the tendon of the omohyoid and the tendinous attachment of the scalenus anticus muscle, and the phrenic nerve, which runs obliquely

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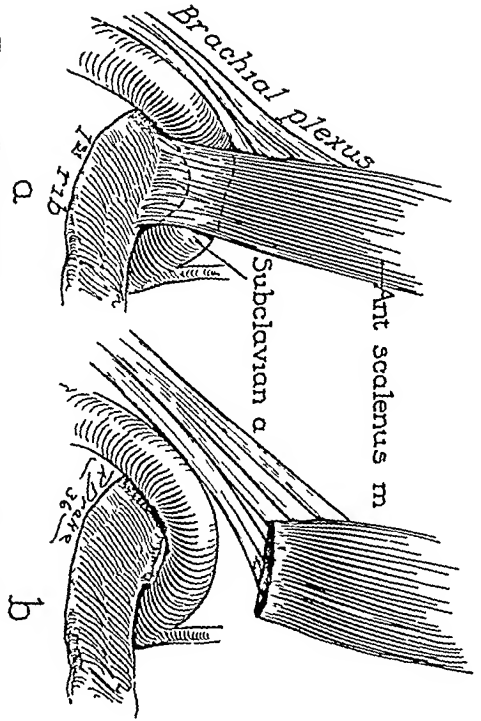


Fig 1—Diagrammatic representation of the scalenus anticus syndrome. (a) Compression of the subclavian artery and brachial plexus before operation, (b) relief of pressure and irritation after section of the scalenus anticus muscle

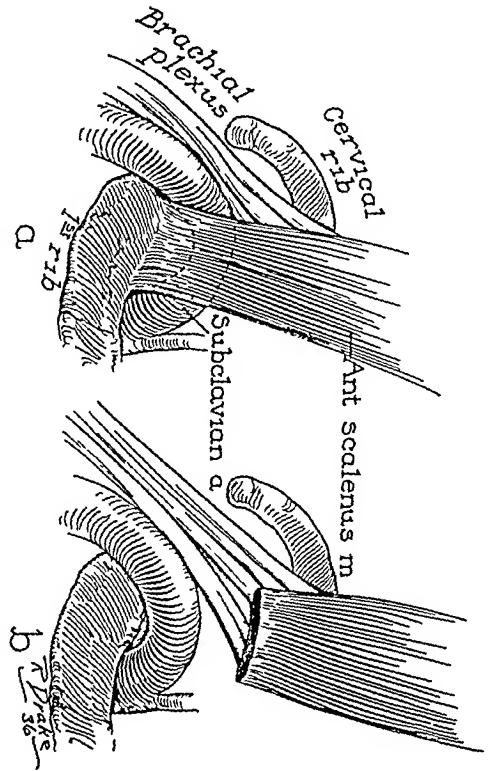


Fig 2—Cervical rib. (a) Rib does not compress the brachial plexus from behind, (b) relief by section of the scalenus anticus muscle

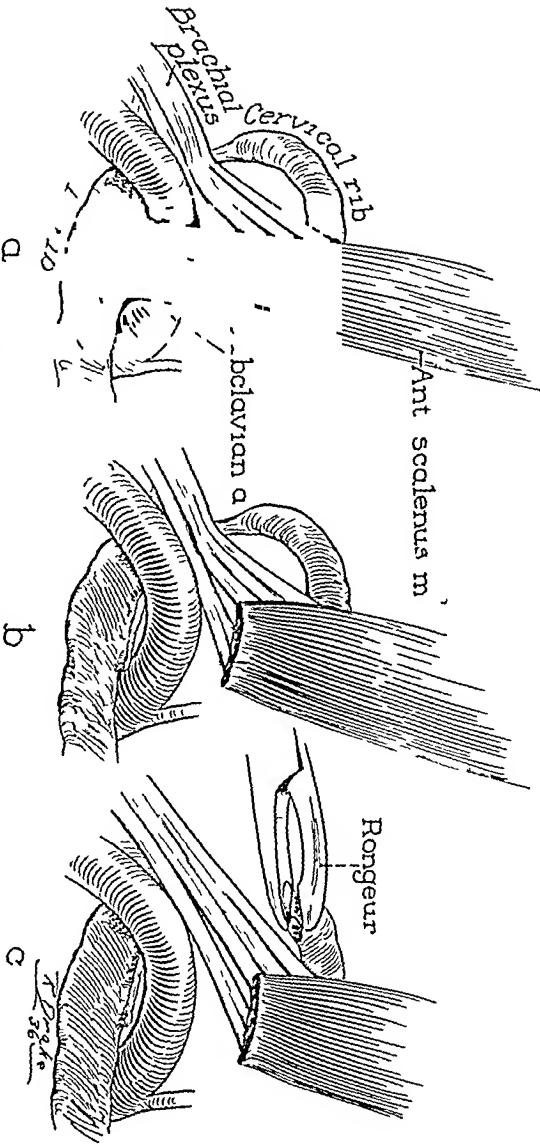


Fig 3—Cervical rib. (a) With tendinous attachments to first rib, (b) not relieved by section of scalenus anticus muscle (c) pressure relieved by using a rongeur on the cervical rib

across it from the lateral to the mesial border. The borders of the scalenus anticus muscle are dissected free and the phrenic nerve is retracted mesially before the tendinous and muscular fibers are divided. The subclavian artery will be seen lateral to the scalenus anticus muscle, and it usually is compressed against the trunks of the brachial plexus (Fig 1). On the mesial side of the scalenus anticus muscle the pleura may be observed and, if dissection is carried still farther mesially, the carotid sheath and vertebral artery will be exposed.

It is important to carry the dissection upward along the anterior border of the scalenus anticus muscle for a distance of 5 cm in order to expose the phrenic nerve thoroughly and to dissect it free before retracting it mesially. The fibers of the tendinous attachment of the scalenus anticus muscle at its insertion are then divided, care being taken that the subclavian artery and pleura are not injured. As soon as the scalenus anticus muscle has been divided, the subclavian artery can be dissected free and will then drop forward. After the scalenus anticus muscle has been divided, the cervical rib is carefully examined, and if it is causing no pressure from behind, no further operative treatment is necessary (Fig 2). However, if the cervical rib or a tendinous attachment to the first rib seems to be compressing the brachial plexus from behind, a portion of the rib and tendon can be removed with a rongeur (Fig 3). In cases of scalenus anticus syndrome, resection of the scalenus anticus muscle is all that is necessary.

In order to emphasize some of the points in the differential diagnosis and the surgical indications and results, the appended six case reports are detailed.

**Case 1**—A male, age 21, came to the clinic complaining of weakness and wasting of the right hand which had been progressive over the previous four years. He first noted some weakness of his right hand and wrist when attempting to write, and was aware of the trouble also when he grasped a football to throw a forward pass. He attributed his disability to frequent injuries which he had sustained in football games and to the strain to which he subjected his right wrist while pole vaulting. This weakness had increased slowly for two years before he noticed that there was wasting and shrinkage of the muscles in the back of the right hand.

General examination gave essentially negative results, including a negative roentgenogram of the cervical portion of the spinal column for cervical ribs. Neurologic examination revealed loss of strength and tonus of the interosseous muscles with marked atrophy. There also was marked atrophy of the hypothenar muscles, with weakness of the adductor muscle of the right thumb. There were no sensory changes but a definite sharp pain extended down the right arm to the fingers when the patient flexed his head on his thorax. The blood pressure in both arms was normal. The radial pulse was obliterated bilaterally on extension of the head with deep inspiration. A diagnosis of scalenus anticus syndrome was made and operation was advised.

Under ether anesthesia, the right and left scalenus anticus muscles were divided. Both scalenus anticus muscles were about three times normal size as were all the other muscles in the neck on account of the patient's athletic activities. Immediately on division of the scalenus anticus muscles the subclavian artery was released where it had been compressed against the brachial plexus, the compression was more pronounced on the right than on the left side. Following the operation the pain was entirely relieved, the radial pulse could not be obliterated on extension of the head with deep inspiration, and within a year the right hand had assumed its normal appearance and strength.

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**Case 2**—A male, age 20, had operated a hydraulic press three years prior to his admission to the clinic and had noticed that at the end of the day his arms would ache and feel numb. After a month these symptoms had become so severe that he changed his job for lighter work and his symptoms disappeared. Three weeks before admission to the clinic he again took up a heavy type of work and began having shooting pains down his left arm, associated with tingling of the fingers. He noticed that his pain was always worse in the evening and that it occasionally kept him awake at night. He occasionally also complained of the same type of pain in his right arm. Roentgenograms of the cervical portion of the spinal column gave no evidence of cervical ribs. Both radial pulses could be obliterated on extending the head during inspiration. A diagnosis of scalenus anticus syndrome was made, and the scalenus anticus muscles were divided bilaterally and were found to be compressing the subclavian artery and the brachial plexus. This pressure was completely relieved at operation, and, after an uneventful convalescence, the patient returned to the same type of work which had been causing his symptoms and remained free from pain and discomfort.

**Case 3**—A female, age 34, four years prior to examination had noticed the gradual onset of a peculiar feeling in her hands and shoulders which she described as pain, tingling, and numbness. This had been greatly aggravated by her work as a stenographer. The symptoms first developed in the left hand and soon involved the entire arm, the right arm then became involved. The symptoms became so severe that it was necessary for the patient to stop typing and rub her hands and shake them several times a day in order that she might proceed with her work.

On examination tenderness was present in both supraclavicular fossae, but a roentgenogram of the cervical portion of the spinal column revealed no signs of cervical ribs. There was almost complete obliteration of the radial pulse on both sides on extension of the head. A diagnosis of scalenus anticus syndrome was made. Bilateral resection of the scalenus anticus muscle revealed compression of the subclavian artery and irritation of the brachial plexus. Following recovery from the operation the patient returned to work and remained completely free of her previous symptoms.

**Case 4**—A male, age 22, four months prior to examination had taken a job as riveter. He soon noticed that numbness and tingling, involving his arms and hands, developed while he was working, and that, in addition, in cold weather his hands would become cold and blue. As long as his hands and arms were at his sides he had no symptoms, but when they were raised at right angles to his body, this numbness and tingling appeared.

A roentgenogram of the cervical portion of the spinal column revealed bilateral cervical ribs and the radial pulse could be obliterated on extension of the head. Bilateral resection of the scalenus anticus muscles was performed and the compression of the subclavian artery was relieved. The patient returned to his work as a riveter and had no further trouble, even in cold weather.

**Case 5**—A male, age 48, since the age of 16 had noted intermittent numbness in the fingers of both hands, this was worse on the right side. He noted that the numbness came on during the night, especially if he slept with his head on his arm. He said that he had noticed that he could produce this numbness any time he elevated his arm, as in driving a car or in doing overhead work. He had also noticed that this numbness disappeared in from five to ten minutes after replacing the arms in a dependent position. In view of the fact that he was an electrician his symptoms were incapacitating.

On examination there was almost complete obliteration of the radial pulse in both arms on extension of the head, and a roentgenogram of the cervical segment of the spinal column revealed bilateral cervical ribs. At operation the scalenus anticus muscle was seen to be compressing the subclavian artery on both sides, posteriorly, against the brachial plexus and bilateral resection was performed. The patient returned to his occupation as electrician and was completely free from symptoms.

COMMENT—In the preceding cases the symptoms of cervical ribs and scalenus anticus syndrome have been very similar, and the surgical treatment has been the same because, by division of the scalenus anticus muscle, the subclavian artery and the brachial plexus have been decompressed, following which there was a complete alleviation of symptoms. The question has arisen with regard to the surgical disposal of the cervical rib, when at operation it is evident that pressure is being produced by the rib on the brachial plexus from behind. Adson has demonstrated that the anterior approach, with section of the scalenus anticus muscles, is the operation of choice. It is much more satisfactory than the lateral or posterior approach. In fact, it is now realized that complete removal of the rib is not as important as relieving the pressure on the brachial plexus and subclavian artery. The following is a case requiring more than the usual resection of the scalenus anticus muscle for the relief of symptoms.

Case 6—A female, age 16, had first noticed at the age of five an intermittent pain in the neck and right supraclavicular space which was aggravated by lying down. Two years prior to her examination this pain had become worse, it was more constant and became quite severe when she used her right arm. A year before examination the pain became more severe, and it was projected down the inner aspect of her arm and involved the third and fourth fingers. Six months later she noticed continuous slight numbness of the third and fourth fingers.

On examination there was a definite tumefaction in the supraclavicular fossa on the right, and the pulse could be obliterated by direct pressure, although not by extending the head. A roentgenogram of the cervical segment of the spinal column revealed a large cervical rib on the right. At operation, the usual section of the scalenus anticus muscle was performed, and the cervical rib was found to be attached to the first rib by a tendinous attachment which pressed on the brachial plexus from behind. This attachment was severed with a rongeur, but as the rib still produced some pressure, the entire rib was removed in sections and the brachial plexus was dissected free. Following this there was no pressure on the brachial plexus and the subclavian artery was pulsating normally. The patient was completely relieved of pain and anesthesia in her right hand and arm.

SUMMARY—The clinical picture of cervical ribs and that of the scalenus anticus syndrome are very similar, as are also the surgical indications and operation. The symptoms result from compression or irritation of the brachial plexus and compression of the subclavian artery. Compression may be due to the presence of cervical rib, an abnormally low position of the shoulder, high fixation of the sternum and ribs, low origin of the brachial plexus, or elevation of the first thoracic rib from spasm of the scalene muscles brought about by irritation of the brachial plexus. When cervical ribs cannot be demonstrated, resection of the scalenus anticus muscle is usually all that is necessary to relieve the symptoms. In the presence of a cervical rib without tendinous attachments and without obvious pressure from behind, resection of the scalenus anticus muscle is all that is necessary, but when there is evident pressure from the cervical rib or its tendinous attachment, resection of the rib and the attachment should be carried out.

In carefully selected cases in which the symptoms point clearly to either cervical rib or the scalenus anticus syndrome, the surgical result is usually



excellent Six cases are presented to illustrate the points in differential diagnosis, surgical indications, and results

REFERENCES

- <sup>1</sup> Adson, A W Surgical Treatment of Cervical Ribs Texas State Jour Med, 28, 739-747, March, 1933
- <sup>2</sup> Blair, D M, Davies, F, and McKissock, W The Etiology of the Vascular Symptoms of Cervical Rib Brit Jour Surg, 22, 406-414, January, 1935
- <sup>3</sup> Jones, F W The Anatomy of the Cervical Ribs Proc Roy Soc Med (Clinical Section), 6, 95-113, February 14, 1913
- <sup>4</sup> Ochsner, Alton, Gage, Mims, and DeBakey, Michael Scalenus Anticus Syndrome (Naffziger) Am Jour Surg, 28, 669-693, June, 1935
- <sup>5</sup> Telford, E D, and Stopford, J S B The Vascular Complications of Cervical Rib Brit Jour Surg, 18, 557-564, April, 1931
- <sup>6</sup> Todd, T W The Descent of the Shoulder after Birth Its Significance in the Production of Pressure Symptoms on the Lowest Brachial Trunk Anat Anz, 41, 385-397, June 15, 1912

## FIBROUS OSTEOMA OF THE JAWS

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TUMORS of the jaws have to be considered apart from tumors of bone in general. In the first place, many of them are of dental origin which precludes their occurrence in other bones. In the second place, the jaws belong to the group of bones preformed in membrane which differ considerably in growth, repair, and tumor formation from the bones preformed in cartilage.

*Embryologic Considerations*—The maxilla and mandible as well as other bones of the face and cranial vault are derivatives of the scaly armor, dermal bone, or exoskeleton which appears first in the early fishes in the scale of evolution.<sup>1</sup> In higher forms this sinks beneath the skin, articulates with the endoskeleton or cartilage preformed bone and forms in the human the bones that ossify in membrane. Even the mandibular articulation is not related to the earlier cartilaginous gill bars but is rather a secondarily formed diarthrosis between two of these membrane bones.

The maxilla ossifies in membrane from three centers on each side, the maxilla proper, the premaxilla, and the premaxilla. During its ossification a cartilaginous mass develops in the maxillary process which, according to Fawcett,<sup>2</sup> probably is either an accessory cartilage or the anterior end of the palatopterygo-quadrato cartilage. Membranous ossification of the maxilla extends from these three fused centers laterally to include this cartilage, and medially to incorporate part of the lateral wall of the cartilaginous nasal capsule. Thus, while cartilage is present in the field in the embryologic stages, none of the bone of the maxilla appears to be laid down by ossification of it.

The mandible ossifies from one center on either side. This center represents the dentale, a dermal bone present in lower vertebrates. Intramembranous ossification spreads from it to form the body and ramus of the mandible. There are two types of cartilage which develop in the embryonic mandible and become incorporated in the spreading membrane bone. The first is a remnant of Meckel's cartilage. This is an important structure in lower vertebrates. In the newborn infant, however, it is represented only by a small connective tissue cord, the sphenomandibular ligament, and by a scanty cartilaginous remnant extending along the dental canal to a position just back of and below the incisor teeth. The second type of cartilage to be incorporated into the mandible is the so called accessory cartilage that develops at the articulation, along the posterior edge of the ramus and the anterior edge of the coronoid process, and at the symphysis. Sections through these cartilaginous areas in the newborn show signs of growth by a somewhat atypical enchondral ossifi-

cation Benign tumors that contain cartilage and ossify through cartilage may arise in the jaws Five such, four benign and one malignant, have been studied by us They probably originate in connection with remains of these embryonic cartilages, since the relative amount of cartilage present is great

Repair of fractures and of defects in the mandible and maxilla is by the formation of callus which is fibrous in its first stage and which ossifies usually by direct metaplasia without the appearance of cartilage However, experiments by Schaffer,<sup>3</sup> Greve<sup>4</sup> and others to be published by one of us (K S G) demonstrate that in the later stages of ossification of the callus and especially when fracture fragments are separated, hyaline cartilage in small amounts may appear and be replaced by new bone by enchondral ossification similar to the callus of a bone preformed in cartilage

That the great majority of benign ossifying tumors of the jaws are free from cartilage and consist almost entirely of fibrous tissue and bone is to be anticipated from the fact that these bones grow normally by membranous ossification The findings in the cases to be reported and in those reviewed from the literature substantiate these views They have been variously designated in the literature as fibrous osteomata or ossifying or osteofibromata, usually according to whether bony or fibrous elements predominate in the particular tumor

Thirteen cases presenting this lesion, four in the maxilla, eight in the mandible, and one in both bones, have been studied Two others of the maxilla previously reported by Montgomery<sup>5</sup> are briefly reviewed and illustrations of their pathology included

#### A FIBROUS OSTEOMATA OF THE UPPER JAW

Case 1—M S, white, female, age 15, was admitted with the history of a growth that had been noticed on the external surface of the right maxilla above and in the region of the first two molars for two years Examination revealed essentially normal findings with the exception of a swelling of the anterior and anterolateral portion of the right maxilla and a thickening of its entire alveolar margin Figure 1 shows the roentgenologic appearance at that time There is a dense shadow occupying the inferior and lateral half of the right antrum and expanding the walls of the maxilla laterally and inferiorly

At operation the mucous membrane over the tumor was incised and soft spongy bone comprising the tumor was removed with the exception of portions at the orbital margin, about the roots of the teeth, and in the region of the malar bone The tumor was found to fill about one-half of the region of the antrum No unossified areas were found

Microscopic sections (Fig 2) consist of trabeculated bone with cancellous spaces filled by immature fibrous tissue Practically no hemapoietic cells were present There are rows of osteoblasts along some of the trabeculae The diagnosis was fibrous osteoma

The patient received postoperatively 510 roentgen units in divided doses over three months Six and one-half years later there is no evidence of progression of the tumor and the face is symmetrical

Case 2—W P, white, male, age 11, had had a gradually increasing enlargement of the anterolateral region of the left maxilla for three years Examination revealed no abnormalities other than a bony hard tumor in the anterior and lateral portion of the maxilla and including the alveolar process

The patient was operated upon by Dr Frederick Moorhead February 4, 1920 A longitudinal incision was made in the mucous membrane of the gum of the left maxilla

and the underlying bony tumor was exposed and chiseled and curetted away. The cavity was packed with gauze.

The specimen consisted of numerous small and large fragments of spongy bone

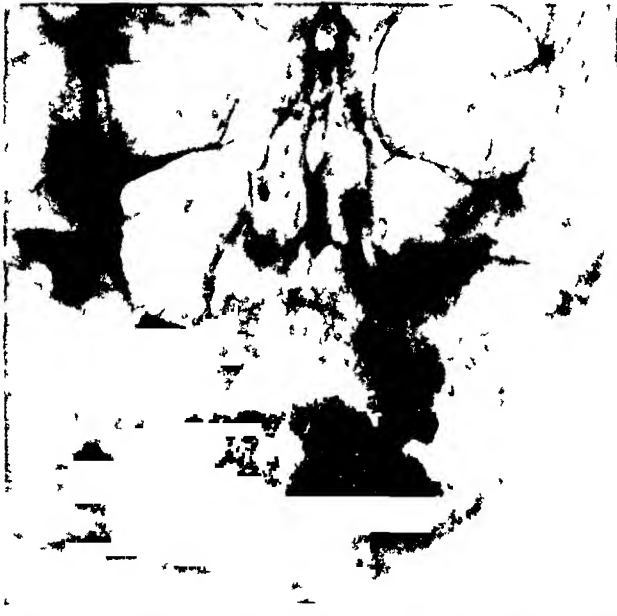


FIG 1—(Case 1) Roentgenogram of the tumor of right maxilla



FIG 2—(Case 1) Photomicrograph of tissue removed

Microscopic examination (Fig 3) shows the tissue to be composed of fine bony trabeculae and of a fibrous marrow. The relative amounts of marrow and trabeculae vary in different regions, but nowhere are large islands of purely fibrous tissue seen. Newly forming

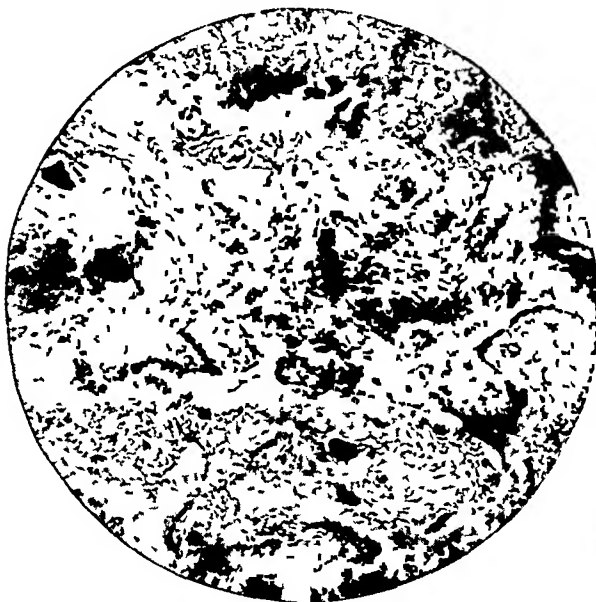


FIG 3—(Case 2) Photomicrograph of tissue removed showing spongy bone, fibrous marrow and giant cells



FIG 4—(Case 3) Photograph of the osteoma of hard palate at seat of palatine torus

trabeculae are numerous. Scattered throughout the sections are numerous large foreign body giant cells. There are no evidences of mitosis. The diagnosis was fibrous osteoma.

This tumor is almost identical with that in Case 1 except for the scattered areas containing giant cells. About ten years after operation the growth had remained controlled.

Case 3 —J McM, white, female, age 29, was admitted with the history that five years ago she first noticed a swelling of the hard palate (Fig 4) During the last three months the overlying mucosa had become slightly ulcerated There had been no period of rapid growth

Examination revealed a bony hard tumor 2 cm in diameter bulging down from the posterior portion of the middle of the hard palate, a distance of 1 cm, and a small superficial ulcer in the mucosa A roentgenogram revealed an oval shadow of increased bone density in the region of the swelling

Under local anesthesia a 2½ cm incision was made through the mucosa of the palate and the oval protruding tumor was chiseled off sufficiently to give the palate its normal contour

Microscopic examination showed a dense cortical bone with small marrow spaces

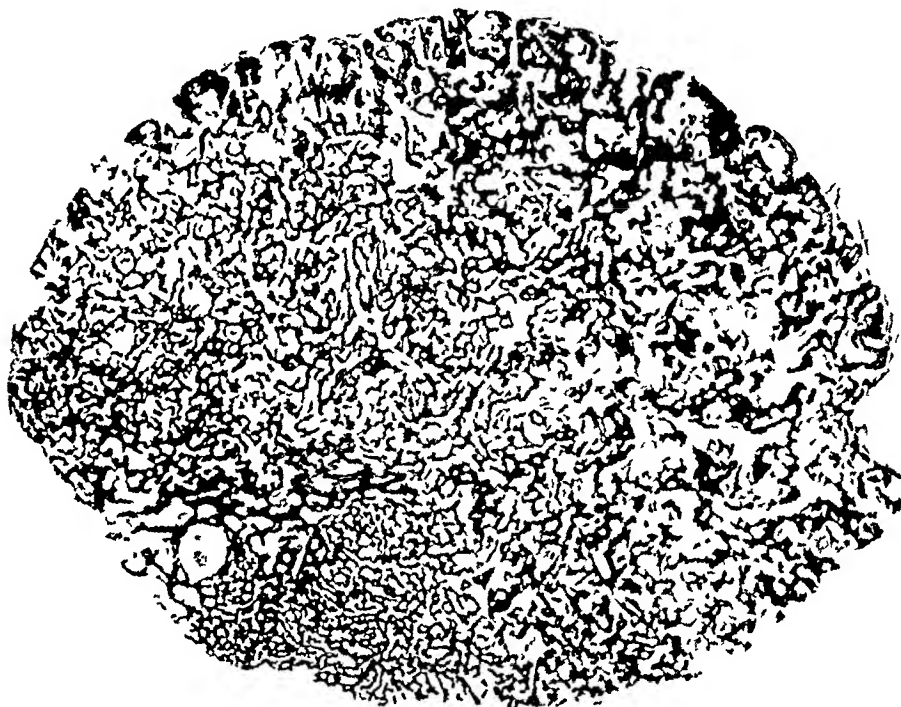


FIG 5 —(Case 4) Photograph of a section at middle of excised tumor

containing partly fibrosed and partly fatty and hematopoietic marrow Beneath this cortex was a loose cancellous bone with large irregular marrow spaces that contained a fatty marrow in which a sparse sprinkling of hematopoietic cells was present This cancellous bone was penetrated by one broad and one narrow band of more compact spongy bone The trabeculae of the latter stained heavily with hematoxylin and were separated by a richly cellular completely fibrous marrow

This lesion was at the site of occurrence of the palatine torus and might be regarded as an unusually large hyperostosis but the presence of much fibrous marrow in the cancellous bone makes it seem more logical to classify it as an osteoma H C Greve<sup>9</sup> is of the opinion that large tori are osteomata

Case 4 —M B, white, female, age 28, had noticed a small lump on the maxilla adjacent to the left side of the nose eight years previously It had enlarged very slowly Examination was essentially negative except for the bony hard swelling which bulged forward from the maxilla just beneath the mesial orbital margin and measured about 2½ cm in diameter at its base The Wassermann was positive

In July, 1913, an oval bony tumor 2 x 2 x 2½ cm was removed Microscopic examination of a section taken through the middle of the entire tumor (Fig 5) showed it to be made up of fairly dense cancellous bone containing a fibrous marrow which was richly cellular in some regions and markedly collagenous in others There was a thin

irregular cortex along the external surface. There was a very small amount of fatty and hematopoietic marrow present. The trabeculae in several large areas were more slender, more continuous, and more closely adjacent. There were no areas of active new bone formation and no large areas of fibrous tissue. The marrow spaces were filled with fibrous tissue that was quite mature, with areas in which the cells were separated by numbers of collagen fibers. No areas of fatty or hematopoietic bone marrow were present. Diagnosis: Fibrous osteoma of maxilla.

We have had occasion to study the pathology of Cases 2 and 3, reported by Montgomery, and are reviewing them with the inclusion of illustrations which were not in his publication.

*Montgomery's Case 2*—A male, age 66, had had a tumor removed from the right maxilla 12 years before, but it had recurred in the posterior alveolar region where there was a large oval protruding mass which was bony in its anterior portion and soft posteriorly. A roentgenogram (Fig. 6) shows dense bony shadow in the region of the



FIG. 6—(Montgomery's Case 2.) Roentgenogram of the tumor of maxilla partly ossified. Unossified portion displaces tooth backward.

antrum. At the posterior limits of the maxilla is a shadow of a tooth obliquely placed but with absence of a bony shadow between it and the antrum. Above and anterior to the dense shadow in the region of the antrum is the shadow of a second tooth. There are no shadows of any of the other teeth in the upper or lower jaws.

The maxilla, including the tumor, was resected. The specimen was sectioned sagittally. Its anterior and superior portions consisted of bone. There was a tooth imbedded in the anterior portion and in the superior portion there was a yellowish dense calcified area. The posterior and inferior two-fifths,

which had grown recently, consisted of soft tumor covered inferiorly and laterally by mucous membrane. There was a tooth imbedded in its posterior portion.

Microscopic examination of the ossified portion showed it to consist of dense cancellous bone. The marrow spaces in the regions that bordered on the soft tumor were filled with fibrous marrow, while some of those more remotely situated contained fatty and hematopoietic marrow. The dense yellow area in the superior part of the specimen consisted of calcified connective tissue which was undergoing bony replacement at its periphery (Fig. 7). Sections of the soft tumor consisted for the most part of immature connective tissue with wavy collagen fibers and oval to spindle shaped cells. There were mucoid regions in which collagen fibers and cells were few. At the junction of the ossified and unossified portions there were newly formed trabeculae extending into the soft tumor. The diagnosis was ossifying fibroma or fibrous osteoma with areas of calcification and mucoid degeneration.

*Montgomery's Case 3*—A male, age 62, had a hard inverted tongue like projection of 18 years' duration from the hard palate into the mouth. The tumor was removed. It was reported by Montgomery. We have had occasion to study the pathology of the tumor and are presenting illustrations of it here. Figure 8 is a photograph and Figure 9 is a roentgenogram of the excised tumor. More than one-half of the tumor consisted of soft tissue. The superficial portion was fibrous with a covering of mucous membrane but

## FIBROUS OSTEOMA OF THE JAWS

its deeper portion consisted of bone which extended into the tumor and sprang from the maxilla

Microscopic examination (Fig 10) showed that the soft portion consisted of fibrous tissue which in most of its extent was rich in irregularly coursing strands of collagen



FIG 7—(Montgomery's Case 2) Photograph of tumor removed showing fibrous area partly calcified (A) Bone, (B) Calcified area, (C) Fibrous area

fibers and contained a variable number of spindle shaped nuclei. In other places there were large mucoid spaces that were poor in collagen fibers and contained scattered branching and pyramidal nuclei. The base of the tumor contained dense mature bone with fibrous marrow from which irregularly branching rays of bone extended into the soft parts

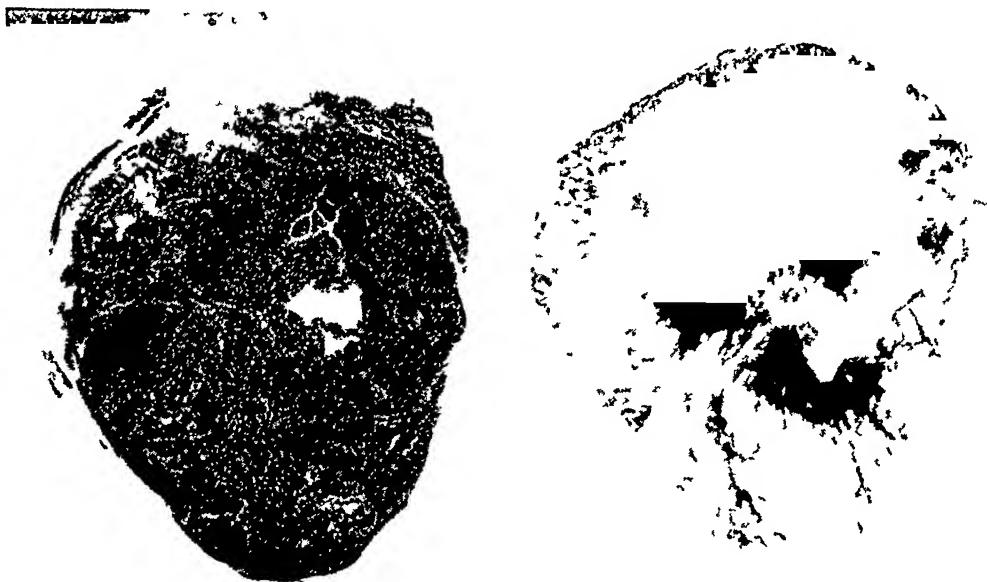


FIG 8—(Montgomery's Case 3) Photograph of buccal surface of tumor removed

FIG 9—(Montgomery's Case 3) Roentgenologic appearance of the tumor removed (Fig 8)

**Diagnosis** Because of the predominance of fibrous tissue in the case the term "ossifying myofibroma" is more appropriate than fibrous osteoma, although eventually the entire tumor might have ossified

## B FIBROUS OSTEOMATA OF LOWER JAW

Case 5—A female, age 29, was admitted with the history that at the age of 12 she had first noticed a tumor of the left side of the body of the mandible. Several teeth



FIG 10—(Montgomery's Case 3.) Photomicrograph of the tissue at junction of bone and soft part of tumor shown in Figure 8

were then removed from the involved area. At 16 the tumor was partially excised. Sections obtained of the tissue (Fig 11) showed trabeculated bone with the cancellous spaces filled with richly cellular fibrous marrow. There are scattered giant cells and rows of osteoblasts along the trabeculae.

The tumor had slowly enlarged. Examination at the time of admission was essentially negative except for an oval swelling of the left half of the mandible which extended from the left angle of the jaw forward to the symphysis. There was a loss of sensation in the mucocutaneous distribution of the mental nerve. The mass bulged lingually about 1 cm, buccally about 2½ cm, and dentally about 5 cm. It extended above the level of the remaining lower teeth, and in places showed the im-

pressions of the upper teeth. Serum calcium and inorganic phosphate were respectively 10.06 and 4.42 mg per cent.

A roentgenogram (Fig 12) showed an oval expansion of the bony shadow of the entire left half of the body of the mandible of fairly uniform density. The cortical shadow



FIG 11—(Case 5) Photomicrograph of tissue removed

was greatly thinned. An incision was made along the lateral alveolar margin and the periosteum and soft parts reflected downward to expose the bony enlargement. Thirty-five grams of dense spongy tumor bone were chiseled away from the lateral surface to



restore the normal external contour of the mandible. The cortex varied in thickness, being very thin in some places. The tumor removed consisted uniformly of very dense spongy bone. No areas of softening were found.

Microscopic sections showed the same type of spongy tumor bone with fibrous marrow, osteoblasts and scattered giant cells as that removed at the first operation. Diagnosis: Fibrous osteoma. The patient made an uneventful recovery. Four months later there had been no recurrence of the swelling.

**Case 6**—A female, white, age 12, was admitted to Presbyterian Hospital with the history that six years previously a bean sized tumor of the gum of the right side of the mandible had been excised. It recurred and ten months later had grown to the size of a hen's egg. Treatment with cautery and radium had failed to stop its growth. At the

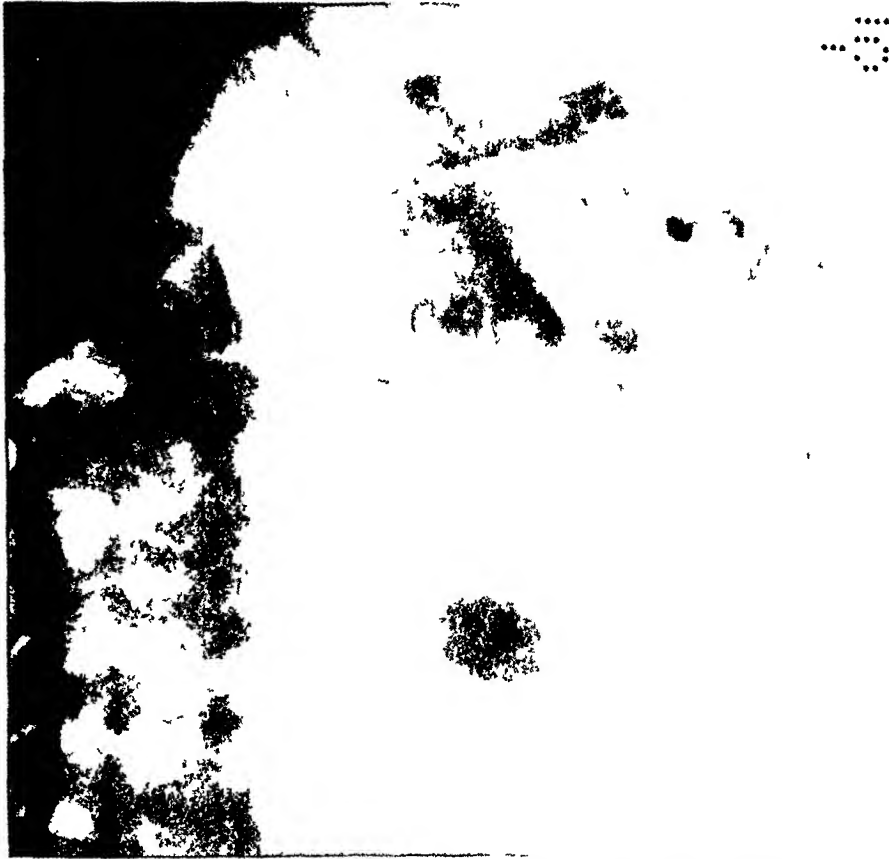


FIG 12—(Case 5) Roentgenogram of the jaw 13 years after partial excision of tumor

time of admission there was an enormous, firm, oval swelling of almost the entire body of the mandible on both sides. On the right side all the teeth but the last molar had been extracted, while the five remaining teeth on the left side were markedly displaced.

A roentgenogram (Fig 13) showed loss of the normal shadow of the body of the mandible except about the left angle. There were radiating streaks of faint bony density extending outward into the faint shadow of the tumor which replaced the body. There were two shadows of radon seeds in its anterior portion.

At operation the entire tumor was removed en masse by Doctor Gatewood. Figure 14 is a photograph of the superior surface and Figure 15 of the cut surface of the excised specimen. The tumor consisted of firm, gray, soft tissue containing scattered radiating trabeculae of bone (Fig 16).

Microscopic examination (Fig 17) showed it to consist of loose fibrous and myxomatous tissue containing a few radiating spicules of bone. There were no signs of mitosis. Along the periosteal surface, at a point where bony spicules came to the periphery, there was a very thin layer of calcified cartilage which was being replaced by bone and appeared to be formed from the distended periosteum. This was the only

region in which cartilage was seen in the tumor. Two explanations for the presence of this cartilage have to be considered. One is that the tumor arose in bone that was preformed in Meckel's cartilage. By far the more probable explanation is that the tumor arose from membrane, and that in the process of rapid growth a small amount of cartilage appeared in the process of ossification similar to that frequently seen in tumors and proliferative processes in the long bones and occasionally in the healing of fractures of the mandible. Since the fibrous element greatly predominated over the bony, the most appropriate name for the lesion would be ossifying fibroma.

The operative defect was repaired by a curved rib transplant and the chin was subsequently built up by a series of plastic operations. There has been no recurrence of the tumor in the nine year interval following the operation. However, the deformity is still severe and the case illustrates the necessity for avoidance of extensive resection of bone when possible.

**Case 7**—A report of this case has been previously published.<sup>7</sup> A resume with illustrations is given here.

M. O'N., white, female, age 18, had a hard oval swelling in the left antero-lateral surface of the body of the mandible that had been gradually increasing in size for four years (Fig 18). On examination the tumor was of bony hardness. Within the mouth it extended from the second left molar anteriorly and around to the right bicuspid. It also extended upward into the alveolar process about the base of the teeth.

A roentgenogram (Fig 19) revealed the shadow of a large oval swelling of the mandible with a thin dense cortex and a faint mottled interior. The tumor was removed through an inframental incision and the defect was repaired with a horse-

shoe shaped transplant cut transversely from the upper end of the tibia. On section there was a thin bony cortex and interior filled with firm soft tissue throughout which were scattered small islands of bone.

Microscopic examination showed it to consist of a richly cellular immature fibrous tissue scattered throughout which were islands of spongy new bone. Diagnosis: Ossifying fibroma. Figure 20 shows the cosmetic result 16 months afterwards. There had been no recurrence of the tumor three years postoperatively.

**Case 8**—E. B., female, white, age 37, had noticed a swelling of the gum of the right side of the mandible eight months before admission, since which time it had very slowly increased. Four months previously a biopsy was taken which showed a mosaic pattern of bony trabeculae and fibrous marrow.

Examination was essentially negative except for a hard, smooth, oval swelling involving both sides of the body and part of the ramus of the mandible on the right side. The body measured 3 cm in thickness. The teeth were slightly irregularly displaced. Serum calcium and serum inorganic phosphate were respectively 9.89 and 3.34 mg per cent.

A roentgenogram (Fig 21) showed diffuse reduction in density with mottling of the shadow of the body and ramus of the right half of the mandible, and a thinning of the shadow of the cortex which was enlarged ovaly along the inferior margin.

An incision was made in the buccal mucosa extending from the angle of the jaw forward slightly past the midline. The soft parts were reflected and a strip of the thin



FIG 13—(Case 6) Roentgenogram of the tumor showing it replacing the mandible and containing faint radiating bone, also two radon seeds.

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Fig 14—(Case 6) Resected mandible as seen from above  
Fig 16—(Case 6) Roentgenogram of bisected specimen

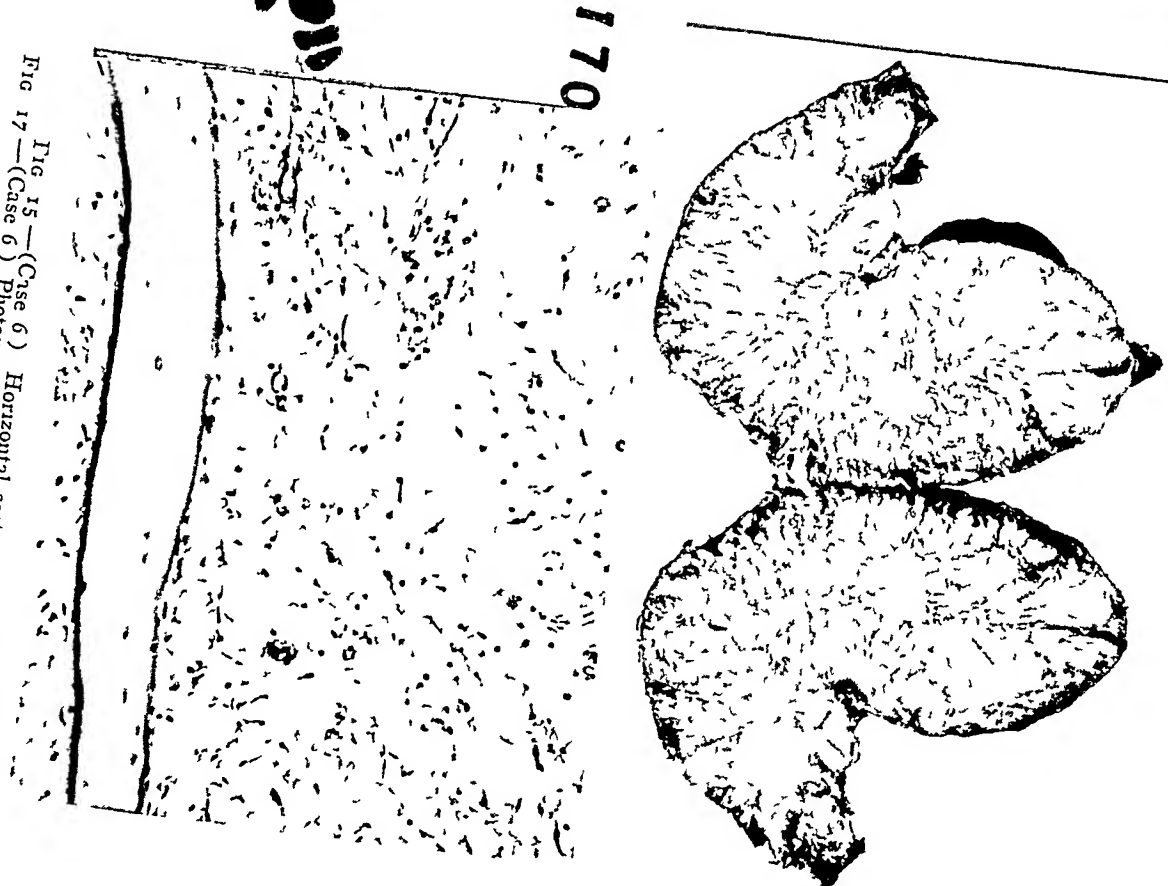


Fig 15—(Case 6) Horizontal section of specimen  
Fig 17—(Case 6) Photomicrograph of ray of bone and soft tumor

cortex running the entire length was removed. The spongy bone of the interior was curetted out exposing the roots of the teeth in places and damaging the mandibular nerve and artery. The overlying mucosa was sutured and a gauze drain inserted.



FIG 18—(Case 7) Photograph of patient preoperatively

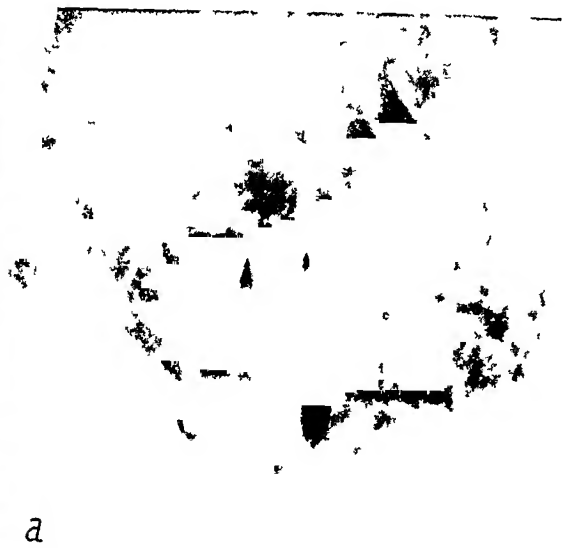


FIG 19—(Case 7) Roentgenogram of jaw

Microscopic sections (Fig 22) show the tumor to be composed of a mixture of cancellous bone and fibrous tissue. In some places the bone was dense and mature, while in others it was extremely spongy and immature. The unossified portions consisted of spindle cells with bands of collagen fibers in many areas and numerous small vascular spaces. Giant cells were frequent in some places. There is no evidence of cell division. Diagnosis: Fibrous osteoma.



FIG 20—(Case 7) Photograph 16 months postoperative showing the cosmetic result obtained by the bone transplant after removal of the tumor

The wound healed with little inflammatory reaction. The patient then received 1,465 roentgen units to the region of the right half of the mandible in divided doses. Ten months after operation there was no sign of recurrence of the tumor.

Case 9—A G, female, white, age 41, was admitted with the history that nine years previously a dentist extracted several teeth and told her that she had a tumor of the mandible. It was then operated upon and subsequently had very slowly enlarged.

Examination at the time of admission was essentially negative except for the right mandible. The molars and second premolars were absent. The right side of the body of the mandible was enlarged from the region of the first premolar backward about 4 cm. Its width was about  $2\frac{1}{2}$  cm. The enlargement involved the inner and outer surfaces of the jaw about equally.

Serum calcium and inorganic phosphate determinations were respectively 10.04 and 4.21 mg per cent.

## FIBROUS OSTEOMA OF THE JAWS

A roentgenogram (Fig 23) revealed a large oval area of reduced density in the middle portion of the right body of the mandible with a jagged circular area of greater density in its central portion. No tooth shadows are in the involved region.

At operation an incision was made near the alveolar margin on the buccal and lingual



FIG 21—(Case 8) Roentgenogram of the tumor of body of mandible



FIG 22—(Case 8) Photomicrograph of the tissue removed

sides of the involved region and enough of the tumor was removed to give the bone its normal contour.

Microscopic examination (Fig 24) revealed a dense mature bone with fibrous marrow which partitions irregular islands of partly fibrous and partly ossified tumor tissue. The ground substance of the spongy tumor consisted of an abundance of spindle cells arranged in whorls and bands among various numbers of collagen fibers. Scattered through most



FIG 23—(Case 9) Roentgenogram of the tumor in body of mandible

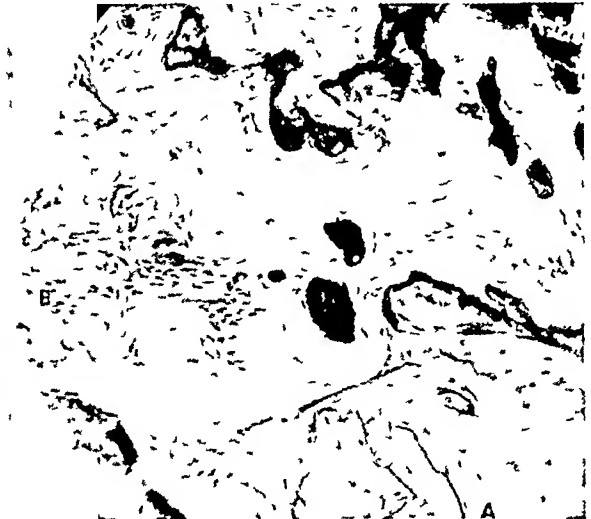


FIG 24—(Case 9) Photomicrograph showing (A) Dense tumor, (B) Partly ossified tumor

of its extent were fine irregular bony trabeculae which stained deeply with hematoxylin. In other regions there were islands of osteoid tissue staining faintly with eosin. Giant cells and hematopoietic cells were absent. Diagnosis: Fibrous osteoma.

The patient recovered uneventfully. 618 roentgen units were then given over the involved area and five months subsequently there had been no change in size of the bone.

Case 10—J. A., female, age 31, had had a tumor of the inferior border of the right mandible that had been present for the past 18 years. Examination was essentially nega-

tive with the exception of the scars from an old osteomyelitis of the right tibia and a smooth, hard, small, rounded tumor protruding from the inferior border of the right mandible

Roentgenologic examination (Fig 25) revealed a small dense semicircular shadow projecting downward from the lower border of the cortex of the body of the mandible opposite the first molar tooth

The tumor was chiseled off under local anesthesia. It was found to consist of a dense bone with no plane of separation between it and the cortex of the mandible

Microscopic examination of a section through the entire tumor showed a small piece of mandibular cortex included with the base of the tumor. Lamina of mature bone that were continuous with the cortex bulged outward to form the tumor base. The marrow spaces of this cortical bone were small and contained a few spindle cells but no fatty or hematopoietic bone marrow. Peripheral to this was a zone of younger and more



FIG 25 —(Case 10) Roentgenogram of the tumor of lower margin of mandible

irregularly distributed lamina and trabeculae of bone with also small partly fibrous marrow spaces. Between this zone and the cortex was a spongy bone layer with fine trabeculae and large marrow spaces that were partly empty and partly filled with fibrous tissue. The cortex was thin and irregular. In several places osteoclasts were attacking it from the inside. Diagnosis: Fibrous osteoma.

The patient recovered uneventfully and three years later there was no evidence of recurrence.

**Case 11**—This was similar to Case 10 and was associated with a fibrous osteoma of the frontal bone.

J. S., age 9, was admitted to the hospital because of a slowly growing bony swelling in the left lateral supra-orbital region of two years' duration, which bulged both anteriorly and into the orbit. Through an incision in the line of the eyebrow the anteriorly protruding portion of tumor was removed. One thousand five-hundred roentgen units were given in six doses during the next three months. Six months later there had been no further growth of tumor, but the portion protruding into the orbit was chiseled away because of the deformity which it produced. Three and one-quarter years after the first admission the patient was readmitted because of a pea sized hard bony swelling of three months' duration at the lower margin of the right mandible opposite the bicuspid tooth. There

## FIBROUS OSTEOMA OF THE JAWS

had been no further growth of the supra-orbital tumor, although roentgenograms showed slightly increased density of the remaining bone. A roentgenogram showed an oval, even bony shadow protruding from the lower mandibular surface opposite the right bicuspid tooth. At operation six weeks ago it was found to be superficially located and was chiseled off.

Microscopic examination of the half oval shaped section showed it to consist of dense spongy bone with marrow, some of which was fibrous and some fatty and hematopoietic. There was active new bone formation along the surface which was covered by a layer of osteoblasts resembling the cambium layer of the periosteum in infancy.

The occurrence of the lesion in association with an osteoma of the frontal bone is good evidence of its benign neoplastic nature and contradicts the view held by some that it is an osteodystrophy or a hypertrophy. Also, the failure of recurrence of tumor after postoperative roentgen therapy of the unremoved portion of frontal osteoma is a point in favor of this procedure for all incompletely removed fibrous osteomata.

**Case 12**—C. T., male, age 50, was admitted with the history that six months previously he had noticed a small lump on the lateral side of the alveolar margin just anterior to the angle of the mandible. He believed that it had enlarged slightly.

Examination was irrelevant except for the left body of the mandible. All the teeth had been removed. In the region previously occupied by the last premolar and first molar teeth the alveolar margin and upper half of the body of the mandible were expanded by a hard painless tumor which protruded about 6 Mm buccally and 2 Mm dentally. The overlying mucosa was intact.

A roentgenogram reveals a slight elevation of the alveolar margin of the body of the mandible about 1 cm forward from its junction with the ramus. The cortical shadow is destroyed. Beneath this in the upper half of the body of the mandible is an irregular area of reduced density. A small irregular area in its center has a density similar to the uninvolved portion of the body of the mandible.

The tumor was exposed through an incision in the overlying mucous membrane and removed. It involved the entire thickness of the mandible and consisted of a dense spongy bone. The patient made an uneventful recovery.

Microscopically the tumor consisted partly of regions of dense bone with fibrous marrow and partly of regions of spongy bone with a marrow that was partly fibrous and partly hematopoietic. The lesion appeared to be stationary and of long standing. **Diagnosis:** Fibrous osteoma.

## C FIBROUS OSTEOMA OF BOTH JAWS

**Case 13**—White, male, age 8, entered the hospital with the history of a swelling in the right maxilla noticed by his parents for three and one-half years. A month before his admission three deciduous teeth at the site of the tumor had been removed and a biopsy taken. Examination was irrelevant aside from the jaws. There was a bony hard enlargement of the entire right maxilla which protruded in the infra-orbital alveolar and palatal regions. No change was observed in the other maxilla or in the mandible. Roentgenologic examination (Fig. 26) showed a dense radio-opaque shadow in the region of the enlarged maxilla and filling out the antrum. There was slight thinning of the shadow of the cortex of the right half of the body of the mandible with slight expansion at the angle of the jaw and an area of circumscribed reduction in density 1 cm in diameter beneath the permanent premolar tooth.

Under ether anesthesia the mucous membrane along the alveolar margin of the maxilla was incised and a spongy bony mass was thus exposed involving the whole enlarged maxilla and extending into the border of the malar bone. The wall was cut away and the interior of the maxilla curetted out leaving a thin shell. Three permanent teeth were removed. No antrum was present. There was a spherical mass of soft myxomatous tissue about 1 cm in diameter in the vicinity of the premolar teeth. The remainder of the

tumor consisted of soft spongy bone. No cysts were present. Figure 27 shows the trabeculae of bone and the fibrous tissue filling the marrow spaces. A section of the soft mass showed it to be composed of myxomatous tissue (Fig 28). No giant cells or



FIG 26—(Case 13) Roentgenogram showing dense tumor of right maxilla, and a beginning tumor in right side of mandible

mitotic figures were seen. Diagnosis: Fibrous osteoma of maxilla containing one myxomatous area.

Because some of the tumor about the walls was left behind it was decided to administer

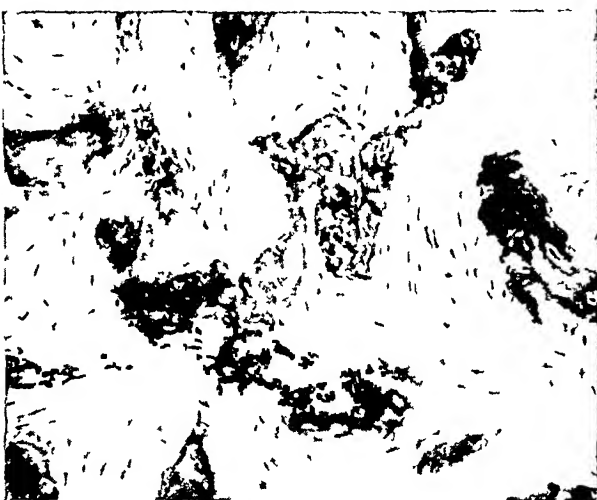


FIG 27—(Case 13) Photomicrograph showing spongy bone with fibrous marrow

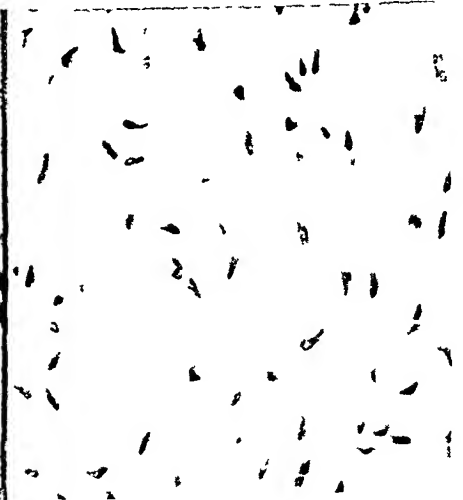


FIG 28—(Case 13) Photomicrograph showing an area of myxomatous degeneration

roentgen therapy in an endeavor to restrain its further growth. During the next 15 months the patient received 3,883 roentgen units to the maxilla and recent examination six years after operation revealed only slight progression in the form of a pea sized nodule on the anterolateral aspect of the maxilla.

A year and one-half after the operation on the maxilla some enlargement was noted



## FIBROUS OSTEOMA OF THE JAWS

of the right half of the body of the mandible. During the next two months it was given 824 roentgen units but the overgrowth continued slowly during the next four years and it extended into the right ramus slightly past the midline anteriorly (Fig 29). A roentgenogram (Fig 30) showed a marked expansion of the shadow of the entire right half and the mental portion of the left half of the mandible. The cortical shadow was thin



FIG 29 —(Case 13) Photograph five years after removal of tumor of right maxilla. The mandible is now the site of tumor formation.



FIG 30 —(Case 13) Roentgenogram made at time of photograph shown in Figure 29.

and the interior faint and mottled with two large areas of greatly reduced density along the inferior margin in the premolar to bicuspid region. Operation was performed for removal of the tumor and restoration of normal contour of the mandible. Serum calcium was 10.08 mg. An incision was made along the inferomesial border of the right half of the mandible and the periosteum reflected to expose the lateral and inferior surfaces of the

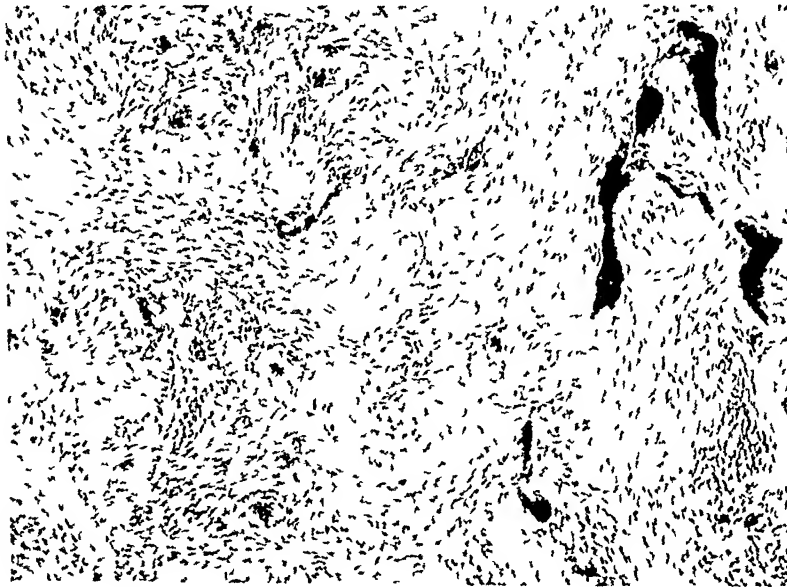


FIG 31 —(Case 13) Photomicrograph of the tissue contained in the tumor of the mandible, showing bony and fibrous areas and many giant cells ( $\times 125$ ).

enlarged bone. Approximately two and one-half centimeters of the lateral surface and two centimeters of the under surface of the mandible were chiseled away. The mental nerve was exposed and preserved. There were two large oval areas of soft tissue which upon microscopic examination proved to be composed of myxomatous tissue of a mature type containing areas of fibrous tissue and areas of calcification and bone formation.

Microscopic examination showed the remainder of the tumor to be more or less extensively ossified. The bone was cancellous and the marrow consisted of cellular fibrous tissue. There were scattered areas of fibrous tissue in which there was no ossification but in some places there were clusters of giant cells simulating the picture of benign giant cell tumor (Fig 31).

Thirteen months after the operation there was practically no further growth of the mandible and the facial configuration had become restored almost to normal.

**DISCUSSION**—Osteomata of the membrane bones in general are frequent, and the literature, old and new, is replete with cases, most of which are incompletely reported. The majority are tumors of the cranial vault and walls of the accessory nasal sinuses. Carl O. Weber,<sup>8</sup> in 1856, reported that in a total of 95 cases, 43 were of the jaws and 52 of the skull and remaining bones of the face. Sjöberg<sup>9</sup> reports a total of 19 osteomata of the maxillary sinus in the literature up to 1935 and adds two more cases.

It is a common experience of dentists to encounter small osteomata on the lingual surface of the alveolus of the mandibular bicuspid which necessitate removal because of their interference with dentures. According to Partsch<sup>10</sup> this lesion is often symmetrical and Greve<sup>11</sup> refers to it as symmetrical mandibular tori. Also a small osteoma or hyperostosis, the palatine torus, is not infrequently observed in the posterior midline of the hard palate that is too small to call for surgical removal.

Numerous medical and dental text-books and journals contain brief and incomplete accounts of cases similar to the 13 here reported. Furedi has recently given incomplete descriptions of 14 cases involving maxilla. A considerable number of cases have also been reported in detail. They have been variously designated as osteofibroma, ossifying fibroma, osteoma, fibrous osteoma, exostosis, localized osteitis fibrosa, osteodystrophia fibrosa localizata, localized Paget's disease, "intra-osseous epulis," and hypertrophic localized osteitis. A summary is given of 30 detailed reports by Hildebrand,<sup>12</sup> Gangnere,<sup>13</sup> Hippel,<sup>14</sup> Uyeno,<sup>15</sup> Menzel,<sup>16</sup> Mauclore and Maurel,<sup>17</sup> Monnier,<sup>18</sup> Montgomery,<sup>19</sup> Moorehead,<sup>20</sup> Kindler,<sup>21</sup> Potts,<sup>22</sup> Konjetzny,<sup>23</sup> Kriegsmann,<sup>24</sup> Renner,<sup>25</sup> Axhausen,<sup>26</sup> and Dechaume.<sup>27</sup> Twenty-four of these tumors began between the ages of eight and 32. The oldest age of onset was 54. Only three of the reported cases were followed more than a year. Seven years was the longest postoperative period of observation. Nineteen occurred in either maxilla and seven in the body of either side of the mandible. One reference was found to a tumor of the maxilla and the mandible on one side in the same patient.

No cases were reported to have undergone sarcomatous change. One lentil sized cyst was reported near an antrum in one tumor, and small cyst like spaces 2 to 5 Mm in diameter were reported in another. Giant cells in small numbers were described in five, and myxomatous areas in one. Trabeculae of new bone in a mosaic pattern and fibrous marrow spaces characterized all the reports.

A history of trauma was emphasized as an etiologic factor in two cases,

a history of caries of the teeth and extraction in 11, and pharyngeal infection in three. Blood calcium had been analyzed in only one case and it showed a moderate hypocalcemia. A positive statement of the remaining skeleton in ten cases described no other bone pathology.

The first available detailed description of this type of tumor was published by Menzel in 1872. It had been noticed in the mandible at the age of ten and had grown in the next 25 years to the size of a fetal head. It was then removed because of threatened obstruction to the air and food passages. The gross and microscopic diagnosis was a benign osteofibroma.

Many years later the histologic resemblance between these localized tumors and the marrow fibrosis with new bone formation of osteitis fibrosa generalisata (von Recklinghausen's disease) was emphasized by numerous surgeons. From this period up to the time of the discovery by Collip,<sup>28</sup> in 1925, of the parathyroid hormone, and the demonstration of its relationship to osteitis fibrosa generalisata by Jaffe, Bodansky, and Blair,<sup>29</sup> in 1930, these jaw tumors were considered by many to be directly related to von Recklinghausen's disease.

In the cases in this study no abnormalities of blood calcium and phosphorus or of the remaining skeleton have been found. Also cysts have been absent and giant cells infrequent. Although the etiology of these tumors is undetermined there seems to be little indication to relate them to osteitis or osteodystrophia fibrosa generalisata or localizata, and similarly they do not resemble Paget's disease or epulis. It appears that, in a general manner, these tumors have a relationship to membrane preformed bone parallel to the relationship that benign cartilaginous tumors and exostoses have to cartilage preformed bone. This view is substantiated by their tendency to begin in childhood and to grow slowly or not at all in adult life as is the case with cartilaginous exostoses.

A study of the histology of this group of tumors brings out the great variability in the amount of fibrous and osseous tissue. Some tumors are composed of rather mature bone trabeculae with partly fibrosed marrow. Others have islands of fibrous tissue undergoing varying degrees of ossification and calcification. There may also be areas of myxomatous tissue and giant cells. In a few the tumor is chiefly fibrous tissue with small amounts of ossification. The terms fibrous osteoma, osteofibroma, and ossifying fibroma are often used more or less interchangeably. The more mature tumors with extensive ossification are probably better called fibrous osteomata, while those in which fibrous tissue and immature bone predominate justify the terms osteofibroma or ossifying fibromata. Round cell infiltration and other inflammatory changes were, in general, conspicuous by their absence.

Symmetrical osteomata have rarely been described, most of the symmetrical jaw tumors being reported as fibromata of the gums (Perthes,<sup>30</sup> Rosenstein,<sup>31</sup> Koblin<sup>32</sup>).

*Treatment*—The treatment of this condition, as detailed in the literature, has been varied. Eleven of the older cases were treated by complete resection, one by partial excision and roentgen therapy, two were biopsied and received

roentgen therapy, and three received no treatment after biopsy. The early treatment by massive resection was very disfiguring and carried a high mortality. In view of the benign nature of the lesion it is no longer justified. Biopsy should certainly be performed as soon as the tumor is noticed, since it is, usually, otherwise impossible to establish its benign nature definitely. The decision not to interfere with a tumor may be justified in some instances in view of the very slow rate of growth and slight disfigurement. The majority of authors agree, however, that the tumors should be operatively removed as thoroughly as possible without too great destruction of the jaw bone. It must be emphasized, however, that one operation does not necessarily cure the patient. The condition may recur and require further partial or total resection.

Irradiation has not been generally used in these tumors of the jaw. Six of the cases here reported with incompletely excised tumors received roentgen therapy. One was markedly, and another moderately, benefited, although the process continued slowly in the other jaw despite irradiation, and four were too recently treated to warrant an expression of opinion. In one recent case a frontal bone osteoma that had been partly removed three years previously and then treated by roentgen therapy has been held in check. The experience in treatment of these patients makes it appear that roentgen therapy is beneficial in controlling portions of the tumor not removed at operation. Authors report benefit from radium treatment but also point out the danger of bone necrosis and slough following its use.

**SUMMARY**—Thirteen cases of fibrous osteoma of the jaws are reported and the pathology of two other recorded cases discussed. The bone was formed by the process of fibrous or membranous ossification, cartilage being seen in a minute trace in only one case. In 12 cases the tumor consisted largely of cancellous bone and fibrous marrow. In three it consisted largely of fibrous tissue in varying degrees of maturation, and ossification was proceeding slowly. There was also myxomatous tissue present in three cases and occasional small islands rich in giant cells in two. Microscopic signs of inflammation were rarely present.

#### CONCLUSIONS

In general, the tumors are slowly growing, and when starting in childhood tend to become stationary in adult life. No case has been recorded which has become malignant. Blood calcium and phosphorus were determined in four cases and found to be normal. The lesion appears to be a true neoplasm and not a form of osteitis fibrosa, hyperostosis or chronic inflammation. The treatment consists in complete operative removal when the lesion is small and circumscribed. But in cases with diffuse involvement of the bone the operation should, as a rule, be limited to partial removal in order to avoid defects in the jaws and extensive disfigurement. Repeated operations may be necessary. Roentgen therapy was found to retard growth of the unresected portion of tumor for long periods in two cases.

REFERENCES

- <sup>1</sup> Romer, A S Man and the Vertebrates, 1933
- <sup>2</sup> Fawcett, E The Development of the Bones Around the Mouth Great Britain Dental Board, 1, 23, 1924
- <sup>3</sup> Schaffer, J Arch f mikr Anat, 32, 266-377, 1888
- <sup>4</sup> Greve, Karl Deutsche Zahnheilkunde, 67, 1-64, 1927
- <sup>5</sup> Montgomery, A H Arch Surg, 15, 30-44, 1927
- <sup>6</sup> Greve, H Christian Deutsche Monatschrift f Zahnheilkunde, 37, 203, 1919
- <sup>7</sup> Phemister, D B Surg Clinics, Chicago, 1, 203, 1917
- <sup>8</sup> Weber, Carl O Die Enostosen u Enchondrome Bonn, 1856
- <sup>9</sup> Sjoberg, Arne Acta oto-laryng, 23, 157-166, 1935
- <sup>10</sup> Partsch Chirurgische Erkrankungen der Mundhöhle, der Zehne u Kiefer Wiesbaden, 1917
- <sup>11</sup> Greve, H Christian *loc cit*
- <sup>12</sup> Hildebrand, Quoted by Hippel Lehrbuch der Allgemeinen Chirurgie, 345, 1909
- <sup>13</sup> Gangnere These de Paris, 1910
- <sup>14</sup> Hippel Ztschr f Mund und Kieferchirurgie, 1, 110, 1915
- <sup>15</sup> Uyeno Beitr z klin Chir, 65, 301, 1909
- <sup>16</sup> Menzel, A Arch f klin Chir, 13, 212, 1872
- <sup>17</sup> Mauclore and Mauel Bull et mem Soc anat de Paris, 88, 113, 1913,
- <sup>18</sup> Monnier, L Paris chir, 5, 842, 1913
- <sup>19</sup> Montgomery, A H Arch Surg, 15, 30-44, 1927
- <sup>20</sup> Moorehead, F B S Clin North America, 7, 517-523, 1927
- <sup>21</sup> Kindler, W Ztschr f Laryng, Rhin, Otol, 25, 54-59, 1934
- <sup>22</sup> Potts, H A, and Hatton, E H J A M A, 81, 2015-2017, 1923
- <sup>23</sup> Konjetzny, G E Arch f klin Chir, 121, 567-634, 1922
- <sup>24</sup> Kriegsmann, G Archiv fur Ohren, Nasen, und Kehlkopfheilkunde, 137, 31-36, 1933
- <sup>25</sup> Renner, C Arch f klin Chir, 175, 388-408, 1933
- <sup>26</sup> Axhausen, G Arch f klin Chir, 174, 434-446, 1933
- <sup>27</sup> Dechaume, M Presse méd, 42, 1124-1126, 1934
- <sup>28</sup> Collip, J B J Biol Chem, 63, 395-438, 1925
- <sup>29</sup> Jaffe, H L, Bodansky, A, and Blair, J E Klin Wchnschr, 9, 1717-1719, 1930
- <sup>30</sup> Perthes Die Verletzungen u Krankheiten der Kiefer Stuttgart, 1907
- <sup>31</sup> Rosenstein, P Symmetrische Geschwulste der Mundhöhle Deut Monatschr f Zahnheilkunde, 30, 321, 1912
- <sup>32</sup> Koblin, H A Zur Ursache der Symmetrischen Schwellungen der Zahnfartsatze Virchow's Arch f path Anat, 283, 631, 1932

## FRACTURE OF THE FEMUR IN CHILDREN\*

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It is the universal experience that the prognosis is excellent in uncomplicated fractures of the femur in children. This fact probably accounts for the variety of the treatments which are recommended. Prey and Foster,<sup>2</sup> after a study of all the fractures of the femoral shaft that occurred in Denver, find that the greatest number of satisfactory results were obtained by the use of the Bryant overhead traction in infants and by the use of Russell's<sup>15</sup> balanced suspension in older children.

Eikenbary and Lecocq<sup>3</sup> report 100 per cent perfect functional results with the Russell method in 40 children, the oldest of whom was 18 years and the youngest 19 months. Kellogg Speed<sup>4</sup> recommends Bryant's suspension in children under seven and suspension traction in a Thomas splint in those over seven. Firor<sup>5</sup> concludes that in all children the spica case gives results as good as those obtained by the overhead traction.

West<sup>6</sup> finds his best results from the use of Bryant's suspension for children under three years and by wire traction incorporated in the double spica case for those between three and twelve. Steel and Grossman<sup>7</sup> recommend Bryant suspension in children under five and plating followed by the leg and body encasement in older children.

Such variety of authoritative opinions has created the impression that in fractures of the femur in children good results will be obtained regardless of the method of treatment. The impression is true but true only when the surgeons who are adequately trained and equipped are following procedures with which they are familiar.

The most important consideration in any fracture of a child's bones is that the growth of these bones is still active. Following such a fracture there is a rapid deposit and ossification of callus followed by an equally prompt absorption of excess callus and rectification of deformity usually leading to a result without deformity or impairment of function. This is in accord with Wolff's law, which states "The internal and external configuration of bone is adapted to the function it performs, that bony deformity after fracture and the visible prominences caused by callus tend to lessen or entirely disappear, the sharp angles round off, and new trabeculae form along the lines of stress." It should be carefully noted, however, that while this improves the appearance at the site of any deformity it does not restore normal axes nor remedy other ill effects of malunions. It is not the part of good treatment to depend upon spontaneous correction of shortening, angulation, and atrophy, as one occasionally still sees deformity and shortening with disability.

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# FRACTURE OF THE FEMUR

In addition to this remodeling at the site of the fracture, there occurs an overgrowth of bone in the longitudinal direction which often compensates for any shortening. The most careful study of this phenomenon of compensatory lengthening has been made by David,<sup>8</sup> and Bisgard more recently. By detailed examinations he was able to make the following report on 62 children whose fractured femurs showed shortening on discharge from treatment (Table I).

TABLE I

Cases	Shortening	Reduced to Normal	Incomplete
1	2 ins.		1 to 1 in in 19 mos.
7	1 1/4 ins		2 to 3/4 in. in 5 mos. 5 to 1/2 in in 7 mos
4	11 ins	4 in 15 mos.	
10	3/4 in	3 in 9 mos	3 to 1/2 in in 5 mos 4 to 1/4 in in 8 mos
3	5/8 in	3 in 3 mos	
14	1/2 in	8 in 5 mos	6 to 1/4 in in 4 mos
10	3/8 in	7 in 5 mos	1 to 1/4 in in 5 mos 2 to 1/8 in in 2 mos
11	1/4 in	11 in 3 mos	
2	1/8 in	2 in 2 mos	
62		38	24

In our experience, shortening up to one-half inch need cause no grave concern, providing the alignment is good but our aim now is—no shortening. In a recent survey of an industrial group of 2,000 men, we found 10 per cent with inequality in the length of the legs. Those who had a difference of one-half inch or less were not conscious of the inequality. In other words, inequality up to one-half inch caused no functional disability nor any postural or locomotive change sufficient to attract the attention of other persons. A further interesting observation in this group was that none gave the history of any injury to either leg. Spontaneous inequality therefore occurs apparently fairly frequently. Philosophic consideration might raise the question whether any inequalities noted after fractures are necessarily to be looked upon as being caused by those fractures.

Correct alignment is unquestionably the most important requirement for good results in so far as equality in the length of the legs is concerned. On the other hand, angulation permitting union in a bowed position is to be looked upon as a major failure. Of equal importance with good alignment is the avoidance of muscular atrophy. While insufficient as a rule to interfere with the ordinary use of the limbs, its bad psychic effect upon children is perhaps as great as a lameness produced by gross inequality in the length of the limbs.

Kellogg Speed<sup>4</sup> states that in children between the ages of two and four years callus is normally fully formed in two weeks' time and that in children under 12 years of age, callus is fully formed within three to four weeks. This is important in any consideration of open reduction methods of treat-

ment for the time when such operative interference should be undertaken is considered of great importance

Goetz and Brackertz's<sup>9</sup> experimental work demonstrates there is definite delay in callus formation after open reduction either with or without fixation but that it is not so marked if operation is delayed seven to ten days. Should open reduction in childhood be delayed for seven to ten days, it would be necessary to disrupt almost fully formed callus before any reduction could be accomplished.

**OPEN REDUCTIONS**—Operative intervention in fracture of the femur in a child is a very hazardous undertaking in the management of such fractures. Aside from the possibilities of infection with subsequent osteomyelitis, operation involves scarring of the tissues, at times nerve injuries, longer fixation and delay in the movements of the leg—all inviting musculature atrophy. There is also an apparent delay in solid union in the presence of metal plates. Several surgeons have reported bowing at the site of the fracture following the removal of Lane plates.

Cole<sup>10</sup> reports one patient in whom an intermedullary plate had been used and the child returned in two months' time with a refracture at the site of the original fracture. It was also his experience that abnormal bowing of the shaft served as one of the greatest factors of deformity and disability. In his series of 31 cases, it occurred only in those operated upon.

Conwell<sup>11</sup> found no open reduction necessary in his series of 86 cases and states that operative methods should be used only as a last resort. There undoubtedly is an occasional death definitely attributable to the operation.

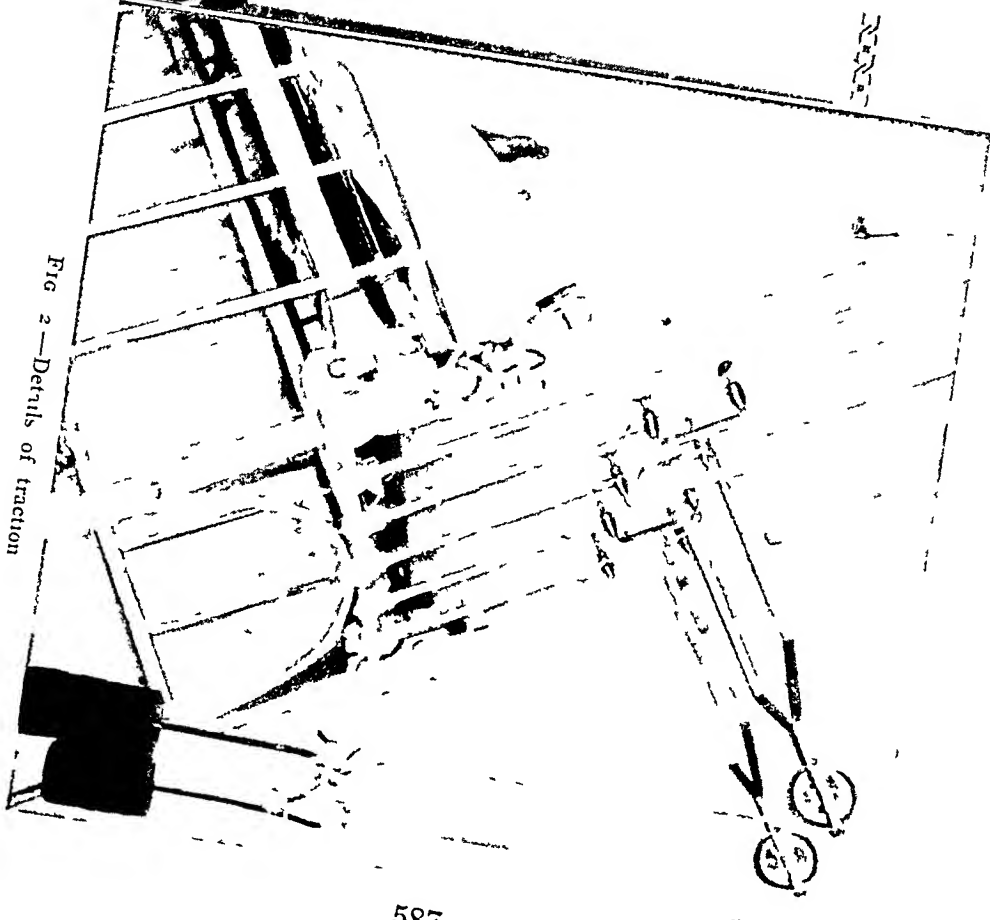
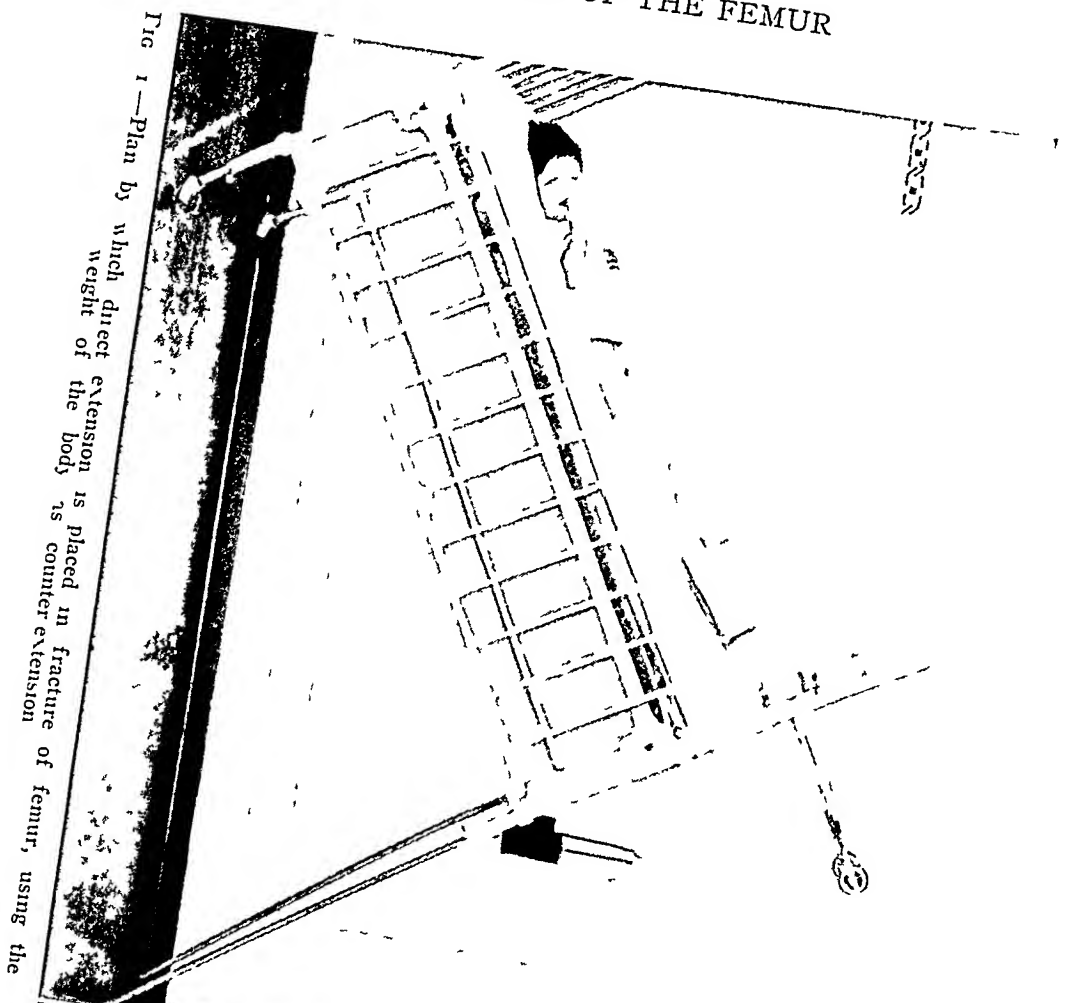
Burdick and Siris<sup>1</sup> reported 268 cases in which operative treatment was resorted to 19 times including bone plating in six cases, open reduction without internal fixation in six cases, calipers in five cases, and Steinman's pins in two cases. They report that an appreciable lengthening of the femur beyond normal was frequently present when operative intervention had been resorted to and that this lengthening was not due to overcorrection except in two instances in which calipers had been inserted, and conclude that open reduction is rarely indicated inasmuch as skeletal traction will invariably correct any marked deformity.

In a series of 30 cases occurring in the Cincinnati General Hospital, L. B. Johnston<sup>12</sup> found open reduction unnecessary. In his opinion, it might be necessary in an occasional fracture of the lower third with the distal fragments in poor position and demonstrated to be irreducible by trial of closed methods.

Orr<sup>13</sup> states that after knowing the restorative power of the injured femur in the young, operation will be rarely resorted to in order to obtain good functional results. This opinion was drawn from his experience in the case of a boy 11 years old who had a transverse fracture of the upper third of the right femur. In a Hodgen's splint, with very little traction, two inches' overlapping resulted in two weeks. In a better splint with increased traction, it was impossible to overcome the entire shortening and the fracture united.



# FRACTURE OF THE FEMUR



with one inch shortening Operation was considered but nature was first permitted to function In eight months' time, there remained only one-half inch shortening and function was perfect

Speed states that in cases where a complete reduction cannot be obtained by closed methods surgeons must be satisfied with the best reductions possible provided it will result in good function If there is no possibility of good function open reduction is indicated With this, I agree

In general, operations are to be avoided When operations are contemplated the dangers should be given more serious consideration than the apparent indications, for as Eikenbary and Lecocq state, "Many children have been crippled when the surgeon in his anxiety to get a beautiful X-ray result has resorted to open reduction "

PLASTER ENCASEMENT—Since Cushing, in 1898, began the use of spica plaster encasements their use has been common They may be used with or without extension Experience has been varied as to their value

Flier's<sup>5</sup> study of fractured femurs treated in Johns Hopkins Hospital included 102 cases treated by immediate reduction and application of the spica encasement He reached the conclusion that such immobilization does not give satisfactory results in patients over 14 years of age but in children gives as good results as those obtained by overhead extension

Poulsen<sup>14</sup> recommends the use of the plaster spica which is applied while traction is being exerted on the leg and the hip is flexed to a right angle With this method he has been able to obtain good results in some cases in which overhead extension has failed to reduce the deformity

Johnston, on the other hand, found in 30 cases that in transverse fractures in children between five and ten, the double plaster spica gave the most unsatisfactory results His experience was that the patients were most difficult to handle and fluoroscope, that the fragments often slip, and if malposition occurred it might not be discovered for two or three days, when open reduction is difficult Kellogg Speed also found plaster encasements were inadequate to maintain extension and alignment of the fragments, which corresponds with our own experience

With continuous extension, however, Burdick and Siris report satisfactory results in older children Conwell<sup>11</sup> also found that better results were obtained in the older children when a plaster encasement plus extension was used The preponderance of opinion is that the encasement is more suitable for the older child In the younger child it is almost impossible to get a form of splint or case which can be kept from being grossly soiled by excreta Even in the older children, there are often serious effects upon the joints and muscle wasting from the application of a plaster encasement with delay in the return to normal function Its use has been stimulated by the inadequacy of the Bryant extension for the older child In my service it is only used after union has occurred and where the transportation of the patient is desirable

Burdick and Siris in summarizing their personal experience adequately

express the general opinion regarding the use of splints "With the Hodgen or Thomas splint, children would toss and tilt the splint to the sides, the rings were either too large or too small, occasionally the ring became moist or the skin traction would slowly slip down over the heel and malleoli producing a sloughing of the skin unless carefully guarded against. In cases where the knee was flexed and the extension was made only on the thigh the constant wriggling of the patient who only occasionally cooperated would frequently tear off the adhesive traction tapes. The method requires constant vigilance. The advantages claimed that active and passive motion can be begun at the onset with consequent early functional recoveries does not warrant their use except perhaps in compound fractures with ulceration or severe trauma to adjacent tissues where the administration of an anesthetic is contraindicated or where skeletal traction is to be employed."

There is almost unanimous agreement that for the younger child the Bryant, one or both legs, vertical suspension treatment has given the most satisfactory results. It can be carried out at home because of its simplicity and the ease of nursing care. It permits frequent inspection, actively maintains muscle tone, and permits return to normal function in a shorter period of time than any other treatment.

Such suspension is limited roughly to children under the age of eight. I use it only on babies. The older child's heavier weight will frequently tear off the extension tapes permitting sagging of the fragments and requiring frequent reapplication.

The Russell<sup>15</sup> balanced traction method is used widely and successfully in the older child. Prey and Foster, and Eikenbary and Lecocq prefer it for all ages. As Russell himself and Lee and Veal<sup>16</sup> point out, the method requires meticulous attention to details of the Russell suspension. It requires frequent adjustment and must be personally inspected not less than twice daily by the surgeon who is thoroughly conversant with its requirements, if satisfactory results are to be obtained. My experience was most satisfactory.

Because of these limitations of the suspension methods, the use of splints, plaster encasements, and open reductions has found favor in the older age groups. With experience, these latter methods have in turn been extended to include the younger age groups. It is quite obvious from the few references quoted that these methods contain greater hazards and limitations than the suspension method, except in a few exceptionally experienced hands, and I think they will agree with me that this 45° extension has less adjustment to make and is almost fool proof.

My own experience parallels that of the surgeons reviewed in this survey. We have seen merit in every method and in certain cases have found each method ideally suited to meet special indications. For the routine care of all cases, however, each method has its limitations and hazards.

To avoid these limitations we have recently adopted the scheme of placing extension upon both legs and thighs by means of adhesive plaster and elevating the foot of the bed to a height where the bed stands approximately at a 45°

angle with the floor The idea is simply that of a Buck's extension with the added feature of high elevation of the foot of the bed Boards placed under the mattress and spring prevent sagging of the bed Pillows should not be allowed as they tend to prevent extension Its traction effects are identical with those of Bryant's extension with the advantage that it can be used in older children up to the size of the average 12 year old child I have used weights over pulleys for extension but feel reasonably certain that results would be quite satisfactory if the extension straps were simply fastened to the elevated end of the bed In practice, the weights do enable us to regulate the amount of extension and we usually use more weight on the injured leg than on the uninjured one Having the head hang low does not seem to annoy the children, and to my surprise they eat up hill without any difficulty

Nursing care and examinations are simplified, active tone of the musculature is maintained, after a week or two, the children roll about and partially sit up The use of the bed pan does not seem to cause any displacement as the extension is always present

Our results have been so satisfactory that we feel justified in reporting the 11 cases in which we have used this method (Table II)

TABLE II

Cases	Location	Age	Days	Length
1	Middle third	11	39	Equal
2	Lower third	7	59	Equal
3	Middle third	6	57	0.1 in shortening
4	Upper third	3	50	Equal
5	Middle third	3	58	Equal
6	Junction upper and middle third	3	49	Equal
7	Junction upper and middle third	3	50	Equal
8	Middle third	3	46	Equal
9	Middle third	4	39	0.25 in shortening
10	Middle third	5½	50	Equal
11	Upper third	9	39	Equal

In a follow up made by Dr Wm Decherney, he reports the following—no angulation or deformity in any of the cases, one patient has one-quarter of an inch lengthening, the remainder show equal measurements

# REFERENCES

- <sup>1</sup> Burdick, C G, and Siris, I E ANNALS OF SURGERY, 77, 736, 1923
- <sup>2</sup> Prey, Duval, and Foster, J M Am Jour Surg, 25, 116, 134
- <sup>3</sup> Eikenbary, C F, and Lecocq, J F Jour Bone and Joint Surg, 14, 801, 1932
- <sup>4</sup> Speed, Kellogg Fractures and Dislocations Lea and Febiger, Philadelphia, 1935
- <sup>5</sup> Firor, W M Bull Johns Hopkins Hospital, 35, 412, 1924
- <sup>6</sup> West, W K Southern Med Jour, 26, 644, 1933
- <sup>7</sup> Steel and Grossman Internat Clin, 1, 228, 1935
- <sup>8</sup> David, V C Arch Surg, 9, 438, 1924
- <sup>9</sup> Goetz, O, and Brackertz, W Arch f klin Chir, 178, 565, 1933
- <sup>10</sup> Cole, W H ANNALS OF SURGERY, 82, 609, 1925

- <sup>11</sup> Conwell, H E Jour Bone and Joint Surg, 9, 593, 1929  
<sup>12</sup> Johnston, L B Arch Surg, 10, 730, 1925  
<sup>13</sup> Orr, T G Jour Kansas Med Assn, 26, 55, 1926  
<sup>14</sup> Poulsen, K Ugesk f Laeger, 86, 140, 1924  
<sup>15</sup> Russell, R H Brit Jour Surg, 11, 491, 1924  
<sup>16</sup> Lee, W E, and Veal, J R Surg, Gynec, and Obstet, 56, 492, 1933

DISCUSSION —DR CALVIN M SMYTH, JR (Philadelphia), Doctor Dorrance has referred to the late Dr John Ashhurst who said that he had never seen a fracture of the shaft of the femur without some shortening. It might not be amiss at this time to quote a statement of the late Dr Astley P C Ashhurst who, in discussing the same subject before this Academy, said that he had never seen a case of fracture of the shaft of the femur in a child in which a good result was not obtained, regardless of the treatment applied. I think that we can all subscribe to this statement. The plan of treatment described by Doctor Dorrance would appear to be identical, at least in principle, with what is popularly known as the British method, that is to say, a Thomas splint tied to the top of a Balkan frame with the limb in abduction and the foot of the bed elevated in order to obtain counter traction by the weight of the body. If we accept the idea that fractures of the shaft of the femur in children are going to get well regardless of the treatment employed, it becomes obvious that each surgeon should use that method which in his case gives the greatest satisfaction. It is my own practice to treat fractures of the shaft of the femur in children by overhead suspension with the Bryant frame. The extension is always applied to both legs and I did not know, until Doctor Dorrance referred to it, that anyone still employed traction on one leg only. In older children we have had excellent results with the Russell method of traction, which is very comfortable but which requires constant supervision to prevent the child from sliding down in bed. This can be overcome by anchoring the shoulders to the head of the bed by means of a canvas vest and shoulder straps. I have employed open reduction in children for only one condition, namely, interposition of soft parts, where, if open reduction is not made, union will not take place. I believe that many fractures of the shaft of the femur in children are operated upon entirely without justification. Doctor Pfeiffer will recall a case a number of years ago in which a competent surgeon had treated a fracture of the shaft in a child three years old and obtained an excellent result with one-half inch overriding. Union was solid but the fragments were not in end-to-end apposition, although the alignment was excellent. Unfortunately there was a trained nurse in the family, which always complicates matters. She saw the roentgenograms and, with the layman's true horror of a roentgenographic deformity, she immediately removed the child from the hospital, took it to a surgeon whose work was concerned not primarily with recent injuries but with late results and chronic deformities of the bone. He proceeded to perform an open operation, broke up the union and put in a plate. This sort of practice might well be termed malpractice.

I have enjoyed hearing Doctor Dorrance's paper tonight although I must say that my sympathies have gone out to the child who has remained so patiently for two hours or more in what looks to me like a very uncomfortable position. I would like to repeat that the way for surgeons to treat fractures of the femur in children is by the method which he finds most satisfactory in his own hands. If this method has been so proven in Doctor Dorrance's hands he will doubtless continue to use it.

# GANGLIA AND SYNOVIAL CYSTS

## THEIR PATHOGENESIS AND TREATMENT

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LITTLE attention has been given to the subject of ganglia and synovial cysts. The causative factors still remain obscure. Several theories have been evolved, none of which adequately explains the several varieties that are seen. Two groups of cases will be discussed in this paper.

*Pathogenesis*—Whether ganglia and synovial cysts are slightly different modifications of the same condition has never been determined. Clinical distinction between the two is often impossible and therefore they are discussed together.

Eller, in 1746, concluded that ganglia resulted from rupture of a tendon sheath with extravasation of the synovial fluid into the tissues forming cysts. Voght suggested that they arose from tendon sheaths, joints and bursae. Gosselin, in 1852, expressed the opinion that they developed from crypts in the synovial membrane and Vinchow thought that they arose from tissue clefts. Ledderhose<sup>5 & 7</sup> probably was the first to advocate the theory that they were formed from degeneration of connective tissue in the periarticular areas. He called them cystomata. It is difficult to conceive how degeneration of connective tissue only in specified areas such as the neighborhood of joints can form cysts and not take place elsewhere. It, therefore, is logical to assume an underlying factor, possibly associated with faulty development of periarticular tissue which may antedate this condition.

Harrison,<sup>6</sup> studying the origin of embryologic connective tissue, concluded that it developed from a gelatinous material in which fibrils were gradually elaborated into delicate net like structure and then into long fibers which were typical of connective tissue. A comparison is drawn of a plasma clot forming fibrin, or of inter- rather than intracellular origin. These early mesenchymal cells are modified to form fibroblasts and other types of connective tissue characteristic of the adult.

Beginning in gelatinous material in which fibrils are elaborated to form connective tissue which further differentiates into synovial membrane, tendons and tendon sheaths,<sup>4</sup> it seems probable that arrests in development might occur and, as growth proceeds, synovial cysts and ganglia could arise. The original faulty development of the tissue in the periarticular areas, and the more extensive modifications necessarily taking place in regions such as the wrist, may account for their greater frequency in this location.

This theory is not new, but seems first to have been expressed by Floderus<sup>1</sup> and supported by Kuttner and Hertel, who regard the process as not one of

degeneration but colliquation causing cavity formation, and in some way physiologic. Cavity formation is a biologic property of synovial tissue, bursae being formed in this manner, although in ganglia and synovial cysts, the bursal functional aim is absent.

The development of ganglia from remnants of ectopic synovial tissue and from highly differentiated embryologic arrests would account for all the varieties that are seen. It should be added that all cysts that are called ganglia do not belong to embryologic abnormalities. The hygromata of bursae are very similar in pathogenesis and morphology, but differ from ganglia in that they have useful function.

It is now commonly accepted among pathologists that these cystomata are lined with mesothelium. Its character seems to be the same, whether ganglia, synovial cysts or bursae (Figs 4, 5 and 7).

Wood<sup>10</sup> states that the lining is made up of long flat cells that do not

form tessellated pavement linings which can be stained with silver nitrate like those of serous membranes such as pleura. Kuttner says that it cannot be true endothelium since there is no borderline between the lining and the deeper cell layer.

At times the blood vessels in the neighborhood of ganglia show changes in the intima and the musculature which may be so pronounced as to cause obliteration of the lumen. At times there is perivascular round cell infiltration which would tend to indicate inflammatory changes. These findings, however, are not constant.<sup>2</sup>

The contents of cystomata are insoluble in water. Sometimes the reaction is that of pseudomucin and sometimes colloid. Detritus, cellular elements, giant cells and fat droplets may be found.<sup>3</sup> The fluid is usually a thick,



FIG. 1.—Ganglion of the dorsum of the left middle finger. Excision under local anesthesia. Fibrous tissue sac intimately connected to the tendon sheath. (Knickerbocker Hospital.)

sticky and viscid substance, grayish in color, but at times it is thin, amber colored, opaque and flows as freely as water

Some observers have inoculated the contents into animals and have been able to show the presence of follicular lesions suggesting a tuberculous origin of these cysts.<sup>8</sup> Plisson<sup>9</sup> believes that only about 2 per cent are tuberculous in origin. In one group of 23 cases from the records of New York Hospital, up to 1932, 13 show positive evidence of tuberculosis on pathologic examination, three were suggestive and seven showed a chronic inflammatory process with no evidence of a tuberculous lesion.

There is little evidence to support the contention that trauma plays a part in the etiology of cystomata.

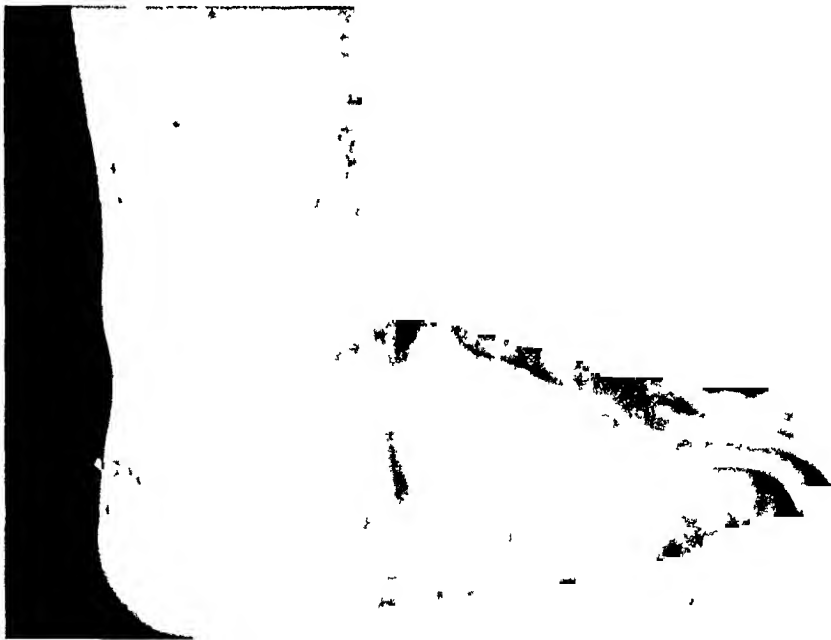


FIG. 2.—Small irregular mass in the region of the peroneus longus, right ankle for ten years. Gradually but slowly getting larger. Diagnosis: Ganglion. Operation under general anesthesia. Mass not encapsulated and consisted of dense fibrous tissue blending into the surrounding connective tissue. Many small lakes of venous blood giving it a dark color. Pathologic Report: Fibrous hemangioma. Eighteen months later, no recurrence. Function of the parts excellent. (Knickerbocker Hospital.)

*Clinical Findings*—With no sharp line of demarcation between them, the cases can be classified into two general groups. Twenty-one cases from the records of Knickerbocker and New York Hospitals fall into the group of simple cystomata. Except for the presence of the cyst, they have few clinical symptoms to distinguish them. The age limit shows wide variation. The youngest in this series was four years and the oldest 67 years, with the largest number appearing in the third decade. The duration of the cyst varied from six months to two years. The patients sought treatment because of the unsightly appearance, and a few because of the fear of malignancy. Two patients experienced slight pain on movement of the parts. One was tender on pressure and none in this group had limitation of motion. One developed



at the site of an incised wound two years after injury. It would be difficult to conclude that this was the result of the original trauma.

Cystomata have been described in the neighborhood of all freely movable joints, but are most frequently present in the region of the wrists. The ratio of males to females, as noted by some observers, is one to three. In this group there were seven males and 14 females, a ratio of one to two. Twelve occurred on the left wrist and eight on the right. One was present on the dorsum of the first interphalangeal joint of the left middle finger. The occupations varied from a child, age four, to an operator of machines, and seemed to have no bearing on the etiology.

#### ILLUSTRATIVE CASE REPORTS IN INSTANCES OF SIMPLE CYSTOMA

**Case 1**—No 55944. New York Hospital. Male, age 51. Occupation, conductor. February 10, 1934. C C. A small cyst had been present on the back of the right wrist for 18 months. It was broken on two different occasions by a sharp blow with a book and on each occasion the cyst recurred shortly thereafter. Examination revealed a soft fluctuant cyst on the dorsum of the right wrist. No tenderness, no pain and no limitation of motion. Operation—February 13, 1934. Under local anesthesia. There was a thick fibrous bulging of the tendon sheaths which extended downward between the tendons. All involved tissue excised.

*Pathologic Report*—Very dense layer of fibrous tissue resembling tendon with hemorrhage into the tissue. Wall of sac found on the surface of tendon or ligament indicates the usual type of inflammation of bursal or joint cavity.

**Case 2**—No 74940. August 29, 1934. New York Hospital. Male, age 63. Occupation, printer. C C. Swelling on the under side of the right wrist, six months' duration. No history of trauma. No pain and no limitation of motion. Examination reveals a small, nontender, fluctuant mass present on the volar surface of the right wrist. Operation—September 5, 1934. Under local anesthesia, a transverse incision was made over the site. The cyst freed to a narrow base and seemed to be connected to the joint capsule. Diagnosis, Ganglion. No pathologic report.

**Case 3**—No 26. Knickerbocker Hospital. November 5, 1935. Colored male, age 4. Three weeks ago a lump appeared on the volar surface of the left wrist. No history of trauma. There is no pain and no limitation of motion. Examination—There is a soft cystic swelling on the radial side, volar aspect of the left wrist. No redness, no increased heat and no tenderness. Diagnosis, Ganglion. Observation advised. The patient returned to the hospital six weeks later because of a rapid increase in the size of the cyst. No other signs or symptoms. Examination the same as previously except that the cyst has increased in size about five times. Operation—January 7, 1936. Under general anesthesia a linear incision was made over the cyst. It was freed from the surrounding tissue, the pedicle extending down to the joint capsule and opening into the joint. At this point it was ligated and cut.

*Pathologic Report*—No mesothelium. The tissue consists of wavy bands of connective tissue.

*Follow Up*—July 7, 1936. Reveals some irregularity of the base of the pisiform bone at the site of the original lesion. No evidence of recurrence. No interference with function.

**Case 4**—No 10351. Knickerbocker Hospital. Female, age 48. Occupation, housewife. October 11, 1935. C C. A small lump appeared on the dorsum of the left middle finger three months previously. She states that she has had the same kind of a lump on the other fingers but they have spontaneously disappeared. Roentgenogram of the fingers reveals no evidence of arthritis. There is no pain, and no interference with function.

The mass varies in size without relation to time Examination—The mass is soft and fluctuant, nontender, and moves slightly on flexion and extension of the finger but does not interfere with motion Diagnosis Ganglion Operation—November 5, 1935 Under local anesthesia, the cyst was isolated and excised It had a pedicle attached to but which did not open into the tendon sheath

*Pathologic Report*—Wavy elastic tissue with round cell infiltration No evidence of mesothelium

This case had lipiodol injected into the cyst for roentgenologic study, which may have altered the pathologic findings



FIG 3a—Schematic drawing of a large cyst on the dorsum of the left hand in a right handed barber Duration three years No pain or redness no increased heat or limitation of motion Distal portion enlarges some on extension of the fingers Diagnosis Ganglion of the dorsum of the left hand After aspiration 1 cc of 5 per cent Sodium morrhuate was injected on three different occasions without change or improvement Again aspirated and 1 cc of modified Carnoy's solution injected There was sudden intense pain in the hand and forearm radiating to the roots of the brachial plexus in the neck Accompanying this was pronounced edema of the hand The hand and arm were splinted, the pain subsided gradually and completely abated in three hours The edema persisted for about one week (Knickerbocker Hospital)



FIG 3b—This shows the result six months later Now, 22 months later, there is no evidence of recurrence and the function of the parts is normal A small ganglion has developed on the volar surface of the same wrist (Knickerbocker Hospital)

Case 5—No 92286 New York Hospital March 16, 1935 Female, age 28 Occupation, social work C C A painless soft swelling appeared on the dorsum of the right wrist eight months previously It has gradually increased in size No pain and no interference with function Examination—A soft nontender, fluctuant mass, about 3 cm in diameter is present on the dorsum of the right wrist No limitation of motion Operation—January 7, 1935 Under local anesthesia, a linear incision was made over the

cyst The sac was isolated with a pedicle which was attached to the medial side of the common extensor tendon

*Pathologic Report*—The tissue is fibrous and is a structure similar to tendon In some places there is sac formation lined with very low mesothelium

In a second group, comprising 23 cases, from the records of the New York Hospital, there were present, in addition to the cyst, signs of further involvement of the tissues as indicated by the frequency of pain and limitation of motion With the exception of one case, this latter sign was present in all the cases of this group The degree of limitation varied, at times so slight as not to be obvious to the patient and at other times rather pronounced The clinical history in all was very similar as well as the other findings on physical examination A "doughy feel" or crepitus of "rice bodies" has been described as characteristic of a tuberculous process "Rice bodies" can be present without evidence of tuberculosis (Fig 6) In this group no such clinical sign was noted Yet a few presented a rather advanced tuberculous process when the tissue was examined Furthermore, some of the structures had been practically destroyed Therefore it is important to state that the examiner should not wait for these two signs before a clinical diagnosis of tuberculosis is made and radical measures instituted

#### ILLUSTRATIVE CASE REPORTS OF GROUP II

**Case 1**—No 264787 New York Hospital American, male, age 41 Occupation, messenger January 3, 1926 C C A small lump suddenly appeared on the back of the left wrist one year ago No history of trauma There has been a gradual increase in size with no pain and no limitation of motion

*History* Gonorrhea six times General physical examination negative On the dorsum of the left wrist, in the midcarpal region, there is a soft fluctuant swelling about the size of a large walnut It moves freely beneath the skin but is attached to the deeper structures It moves some with extension of the fingers No tenderness and no limitation of motion *Diagnosis* Ganglion *Operation*—January 5, 1926 A longitudinal incision was made over the mass, which was really two masses, extending forward over the metacarpals There was a definite capsule connected to the tendon sheaths The masses were opened and a flaky, purulent material was evacuated By sharp dissection an attempt was made to remove all the involved tissue from the tendon sheaths, without complete success Incision closed without drainage Healing by primary union

*Pathologic Report* The wall is fibrous and lined with granulomatous tissue which occludes the vessels *Diagnosis* Granuloma of luetic or tuberculous origin

**Case 2**—No 290149 New York Hospital American, female, age 53 Occupation, housewife December 19, 1929 C C Swelling of the volar surface of the right wrist and pain in the fingers of the right hand for one year She is unable to extend the middle and ring fingers The swelling has gradually increased in size with a very rapid growth in the last month *Examination*—On the volar aspect of the right wrist there is a tense cystic swelling which extends above and below the volar ligament It measures about three by one and one-half inches There is slight tenderness with no redness or heat The fingers are fixed in semiflexion Roentgenologic examination negative Tuberculin test faintly positive *Diagnosis* Ganglion *Operation*—December 10, 1929 A linear incision was made over the mass Just beneath the skin was a large multiloculated mass which extended in and around the tendons and involved the tendon sheaths It was filled with a thin yellow fluid and "rice bodies" By sharp dissection the involved tissue was removed Incision closed without drainage Hand splinted in extension

*Pathologic Report*—The tissue is thick and inflammatory with some necrosis Numerous tubercles are present with secondary fibrosis *Diagnosis* Tuberculous ganglion

**Case 3**—No 297089 New York Hospital January 20, 1931 South American, male, age 22 Occupation, bus boy C C Seven months ago he fell, landing on the outstretched palm of the right hand Following this he noticed a small swelling associated with pain, on the back of the right wrist Since then the swelling has gradually increased in size but the pain has ceased There is slight limitation of motion of the wrist Examination—There is a large, soft, fluctuant mass on the dorsum of the right wrist with no redness or tenderness Some limitation of extension and flexion of the wrist Diagnosis Ganglion Operation—January 21, 1931 A linear incision was made over the mass A large cyst presented which contained necrotic material The process involved the sheaths of all the tendons in the wrist The involved tissue was removed by sharp dissection Incision closed without drainage

*Pathologic Report*—There are numerous white areas in the wall Dense fibrous tissue is present which is infiltrated with lymphocytes There are many giant cells with tubercle formation Diagnosis Tuberculous tenosynovitis



FIG 4—Presumably a synovial cyst largely denuded There are a few scattered cells in the glairy contents (S 34 96, Hist No 4228)

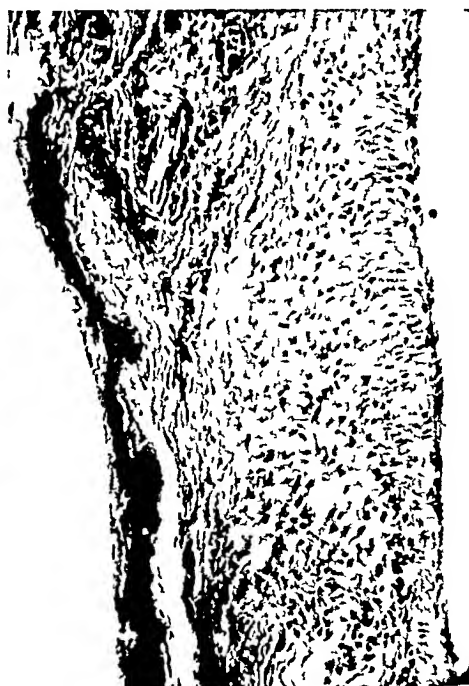


FIG 5—Ganglion The lining cells are quite evident in places (S 34 2170, Hist No 77898)

Patient readmitted June 4, 1931, with recurrence of the mass at the same site, increased limitation of motion and pus discharging from a sinus Operation—June 5, 1931 By sharp dissection the involved tissue was removed Skin closed without drainage

**Case 4**—No 277164 New York Hospital January 2, 1928 Hungarian Jewish male, age 57 Occupation, operator of machines C C A small round swelling developed on the back of the left wrist 13 months previously It has not changed in size No history of trauma No pain except on making a fist Left hand seems weak and therefore uses it less than the right History of osteomyelitis 25 years previously, type unknown Hydrocele three years ago

*Examination*—A semisolid mass about one by two inches in diameter is present on the dorsum of the left wrist and is attached to the extensor tendons Motion is limited to 50 per cent flexion of the wrist and 38° extension Roentgenogram of the left wrist shows no involvement of the bones There is no pain, no tenderness and no increased heat Diagnosis Ganglion Operation—January 3, 1928 A linear incision was made over the mass The process involved all the tendon sheaths except that of the thumb

There was hypertrophy of the synovial fold and fatty infiltration. The process extended down between the fibers of the tendons. By sharp dissection the entire sheath was excised. Incision closed without drainage.

*Pathologic Report*—There is dense fibrous tissue with round cell infiltration and moderate vascularity. There are dense cellular plaques surrounded with fibrin. Diagnosis: Chronic tenosynovitis. There is no evidence of tuberculosis although it resembles a tuberculous process.

The above cases are reported in detail to illustrate an advanced involvement of important structures without clinical evidence of a marked inflammatory process. For this reason the presence of a cyst and limitation of motion with or without pain, however slight, indicates early operation and radical



FIG. 6—This is typical subacute synovitis with numerous masses of fibrin undergoing hyaline degeneration and forming the well known "rice bodies." The process is apparently non tuberculous (S 34 2520, Hist No 9989.)

excision of involved tissue. In general the age group is somewhat higher than in the cases with a simple cyst.

Associated lesions in other parts of the body are infrequent enough to be of little value in arriving at an accurate diagnosis. In only three of this group of 23 cases was there tuberculosis elsewhere. One had had a tuberculous kidney removed, one a tuberculous osteomyelitis and the third developed a tuberculous cervical adenitis seven months after the appearance of the cyst of the wrist. The remainder showed no evidence of the disease from the clinical or roentgenologic study.

*Treatment*—In simple cystoma various methods of treatment have been advocated. The method of breaking the cyst by a sharp blow, causing extravasation of the contents into the surrounding tissue, is still in use. This results in a cure in a small percentage of cases, but the majority so treated recur. Such measures, however, are hazardous, as the character of the cyst may be such as to result in an extension of an inflammatory process which, as already stated, may be present without giving clinical evidence. Case 1 in the first group, as noted, had such a procedure carried out on two different occasions, and as the operative findings indicate would, had there been a low grade inflammatory or tuberculous process present, have resulted in extension

of the process and, in all probability, a destruction of the parts and their function. Case 1 in the second group, as shown, had no clinical signs of an inflammatory process in the cyst, yet the pathology was advanced and, had this procedure been carried out, grave results might have followed.

The "leave it alone" type of treatment is equally harmful and probably is the chief reason for the extensive processes that are so often seen. The injection of sclerosing solutions which has received such widespread recognition as a treatment for other conditions will effect a cure in selected cases. Figure 3b shows the result of an injection of a modified Carnoy's solution.

Operation with complete dissection and removal of the entire cyst wall results in fewer recurrences and it is the treatment of choice. Furthermore, without operative interference, one cannot be certain of the underlying



FIG 7—Ganglion. A small cyst showing desquamation of the lining cells so that they are more evident than they are in situ. The surrounding tissue shows definite subacute inflammation and some hemorrhage. (S 34 2153 Hist No 110407)

pathology. An early tuberculous process may be present without giving positive clinical evidence. If not completely excised, it may extend to the surrounding tissue and destroy the function of the parts.

In simple cystomata without pain or limitation of motion, complete dissection and removal of the sac is important or recurrences may be frequent. In cystomata with pain and limitation of motion, early operation is indicated, as the underlying pathology is usually chronic inflammatory or tuberculous in character. All involved tissue should be completely and thoroughly excised and the incision closed without drainage.

RESULTS—In 21 cases of simple cystomata treated by operation, there were five recurrences, varying from two months to a year. One of these was reoperated upon with no recurrence after three months. In the second group of 23 cases, an inflammatory condition of the cyst was suspected and all were hospitalized for operation. Two cases were followed for one year, and the results were excellent, with no recurrence of the cyst, no pain and no interference with function. One case which, pathologically, showed no evidence of tuberculosis, returned in six months with recurrence of the cyst, and, at the second operation, the scaphoid bone in the same wrist was found to be

involved in a tuberculous process. This was excised. Two years later she had practically ankylosis of the wrist and no motion in the fingers. Another patient with tuberculous tenosynovitis had no recurrence after 18 months, although she felt some pain and there was a small nodule above the site of the previous pathology. One patient, after excision of a tuberculous ganglion, died seven years later of generalized tuberculosis. The sixth patient followed for ten years. Case 1, reported in the second group, had slight dorsal and palmar flexion, pronation complete, supination 50 per cent and all movements of the fingers limited. There was a small swelling on the outer aspect of the dorsum of the same wrist which, he stated, had not changed in size in several years. The other patients could not be traced.

#### CONCLUSIONS

(1) The various theories on the origin of ganglia and synovial cysts are presented, with a comparatively new one restated, that they have their origin in embryologic arrests in the process of the development of the periarticular tissue and synovial membranes.

(2) The morphology and pathology of ganglia and synovial cysts are essentially the same and are similar to the hygromata of bursae.

(3) Clinical distinction between the cystomata that occur in the periarticular areas is often impossible.

(4) Inflammatory disease may be present in these cysts without giving positive clinical evidence.

(5) When a cyst is present with pain and limitation of motion, however slight, early operation is indicated because the underlying pathology is usually chronic inflammatory or tuberculous in character.

(6) Various methods of treatment are presented. Operation and complete excision of all involved tissue result in the highest percentage of cures.

(7) A certain percentage of failures occurs even after the most careful dissection, they can be reduced by early and complete excision of all diseased tissue.

I am indebted to Drs Eugene Pool and George Heuer for their kind permission to review the records of the New York Hospital, and to Dr N Chandler Foot for his generous assistance with the microscopic sections.

#### REFERENCES

- <sup>1</sup> Albertini, A. Henke-Lubarsch. *Spez Path*, 9, pt I, 547-552, Berlin, 1929.
- <sup>2</sup> *Idem*
- <sup>3</sup> *Idem*
- <sup>4</sup> Arey. *Developmental Anatomy*, 310, 1930.
- <sup>5</sup> Clarke, W. C. The Pathogenesis of Ganglia, with a Description of the Structure and Development of Synovial Membrane. *Surg, Gynec and Obstet*, 7, 56, 1908.
- <sup>6</sup> Harrison. *Jour Exp Zool*, 41, 349, 1925.
- <sup>7</sup> Ledderhose. Die Aetiologie der karpalen Ganglien. *Deut Zeit f Chir Bd* 37, 1893, 12.
- <sup>8</sup> Leutlle, M. and Bazy, L. So Called Synovial Cysts of the Wrist. *Ann d'anat path med-chir*, 5, 937, 1928.
- <sup>9</sup> Paire and Bruas. Synovial Cysts of the Wrist and Tuberculosis. *Soc med mil franc*, *Bull mens* 20, 128, 1926.
- <sup>10</sup> Wood, F. C. Personal Communication.

## TWENTY YEARS' EXPERIENCE WITH THE CITRATE METHOD OF BLOOD TRANSFUSION\*

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NEW YORK

THE majority of physicians and surgeons in active practice today do not appreciate the remarkable simplification that blood transfusion has undergone in the past 20 years. The older members of the profession still remember the cumbersome technic which a direct blood transfusion by vessel anastomosis entailed. Direct transfusion represented a major surgical procedure, often lasting over two hours. In addition to the technical difficulties there always existed the uncertainty as to how much blood had been actually transferred from donor to recipient.

However, "necessity is the mother of invention." With advancement in surgical technic and methods, broadening both the indications and the scope for major surgical procedures, it became evident that a simpler method of blood transfusion than the direct method was imperative in order to prepare patients more adequately before operation and to support them in their post-operative course. Furthermore, it was evident that the only way to replace a large loss of blood due to hemorrhage in the shortest possible time was to introduce a simple method for the transfer of blood from donor to recipient.

Thus the different indirect methods were born in rapid succession. Lindeman's syringe-cannula method<sup>1</sup> was followed shortly by the Kimpton-Brown tubes,<sup>2</sup> by the Unger apparatus,<sup>3</sup> and by the citrate method.<sup>4</sup>

In the short space of two years, transfusion had been transformed from a most difficult surgical procedure, requiring expert surgical skill, to a very simple one. In addition, all the indirect methods allowed exact calculation of the amount of transfused blood and thus replaced the inaccuracies incidental to direct transfusion.

In spite of the simplification of the technic, blood transfusion failed to gain general popularity, because of the comparatively great number of post-transfusion chills. The profession felt that in very sick patients—and after all the vast majority of the patients who required blood transfusions were seriously ill—a chill might be of serious consequence to the patient who was hovering between life and death.

Many different theories were brought forward to explain the chills. Some thought that chills could be prevented if specially prepared glassware were used. Others blamed the ordinary rubber tubing and introduced specially manufactured tubing in order to prevent chills. Another suggestion was that the donor should be starved before the transfusion. Others went so far as to apply this principle not only to the donor, but to the recipient.

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Many authors felt that chills could be prevented, if proper safeguards were taken to insure against cooling of the blood during the introduction into the recipient. Even in recent years complicated and expensive electrical apparatus was put on the market to keep the blood at a uniform temperature during the infusion.

I have never used any of these devices or suggestions, as I always felt that none of them was the real cause of posttransfusion chills. I used to surround the glass cylinder containing the citrated blood with hot water bottles. I discarded them a few years ago, as the slight degree of cooling of the blood occurring during a transfusion had no harmful effect on the recipient and did not cause chills. Furthermore, it is unnecessary to put the glass jar with the citrated blood into hot water during the short period required to introduce the cannula into the recipient's vein and to prepare the apparatus necessary for the transfer of the blood.

After all these different theories had been discussed for years, without solving the problem of posttransfusion chills, it was established a few years ago by Rosenthal<sup>5</sup> that chills were due, firstly, to foreign protein reactions, and, secondly, to defects in the distillation of the water.

Careful cleansing of instruments, tubing and glassware immediately after the transfusion is essential. A detailed technic for the safe and thorough removal of old blood which causes these pyrogenic reactions was reported in a previous paper.<sup>5</sup> The great importance of the use of triple distilled water for the prevention of chills was stressed. The importance of triple distillation of the water was doubted by Elser and Stillman.<sup>6</sup> However, its great value in the prevention of chills has been confirmed recently by studies emanating from the Institute for Blood Transfusion in Leningrad.<sup>7</sup>

Following the introduction of this simple technic for the preparation of instruments and solutions, posttransfusion chills on the wards of Mount Sinai Hospital were reduced from 12 per cent (1930) to 12 per cent (October, 1931–October, 1932). An even more marked reduction in the number of chills was observed by Satunov<sup>7</sup> (Novgorod), namely, a drop from 53 per cent to 27 per cent chills after adoption of this technic of carefully cleansing the instruments immediately after the transfusion and of using triple distilled water.

Since the introduction of these new methods, which proved that posttransfusion chills are preventable, the citrate method is now used practically exclusively in our hospital. Up to 1932, the medical services and one of the surgical services had favored the Unger method, because it was assumed that sodium citrate, though the technical simplicity of the citrate method was conceded, was the cause of the frequent chills (Table I).

In other words, in 1932, when the new technic for the preparation of instruments was introduced the proportion between citrate and Unger transfusions was about two to one, in 1935, the proportion rose to about eighty to one.

Most hospitals have selected one method for blood transfusion, using

either citrated or noncitrated blood. In our hospital both the Unger and the citrate method were used extensively for about 17 years. Both methods had their staunch supporters. However, since the reduction of chills to a minimum, the Unger method is hardly used at all any more, even on the medical services where many transfusions are given for a great variety of blood diseases.

TABLE I  
STATISTICAL RÉSUMÉ SHOWING THE RELATIVE USE OF THE  
CITRATE AND UNGER METHODS

	Number of Transfusions	Citrate Method	Unger Method
1923	143	83	60
October, 1931—October, 1932	477	331	146
1935	794	784	10

The present investigation (frequency of posttransfusion chills in 1935) was undertaken to find out whether the chills had been kept at the low level reported in 1932. It is easy to get good results immediately after a new technic has been introduced and every member of the organization tries hard to establish a good record. However, a certain laxity may creep in later and spoil the results. It is gratifying to note that the incidence of chills after citrate transfusions by the gravity method has been kept on the same low level, 1.2 per cent (Table II).

TABLE II  
INCIDENCE OF CHILLS AFTER CITRATE TRANSFUSIONS  
IN 1935

723	Citrate transfusions with 11 chills (including pediatric service 70 transfusions—Hirsch apparatus—with 3 chills, 4%)	1.5%
653	Citrate transfusions with 8 chills (exclusive of pediatric service)	1.2%
Not included in statistics		
Aplastic anemia, 61 transfusions with 12 chills		
Total number of citrate transfusions		784

Of further interest is the fact that with the change in the original method on the pediatric service the percentage of chills rose to 4 per cent in 1935, whereas in 1934, before the technic had been changed, it had been 1 per cent. During the last year this service replaced the gravity method by the Hirsch apparatus.<sup>8</sup> The collection of the blood is the same as with the original citrate procedure. However, the apparatus is used to inject the citrated blood into the vein of the infant.

This apparatus consists of a metal case with two narrow channels, through which the blood is aspirated and injected. The proper cleansing of the channels through which the blood flows is very difficult. Thus old blood is apt to collect and stay in them. The increase in chills observed during the

last year on the pediatric service is due to a foreign protein reaction. The quadruplication of the incidence of chills seems to prove the advisability of adhering strictly to the original technic (gravity method).

I have not included in the statistics three cases of aplastic anemia observed at the hospital during 1935. The extremely high incidence of post-transfusion chills in this disease is so utterly at variance with the low record of chills in all other diseases that it would be unfair to include them in our statistics. They must be due to the underlying disease and cannot be ascribed to a faulty technic of blood transfusion. The first case had 31 transfusions with four chills, the second case had 18 transfusions with eight chills, and the third case had 12 transfusions without a chill. In other words, 61 transfusions for aplastic anemia were followed by 12 chills (20 per cent).

However, I have included in these statistics three cases of posttransfusion chills in ulcerative colitis, though two of these patients had been treated with dysentery serum. One patient had one chill among three transfusions, the other patient one chill among five transfusions, and the last patient had one transfusion followed by a chill. While two of these chills may have been due to a serum reaction, they were included in the statistics.

The results obtained since the establishment of the special department for the proper preparation of instruments and solutions used for intravenous therapy (saline solutions, glucose solutions, blood transfusions) prove conclusively that chills after citrate transfusions can be held permanently at a very low level (about 1 per cent), if the proper technic in the preparation of the instruments and solutions is used. The only change in the administration of a citrate transfusion since its original introduction 20 years ago is the change from a rapid infusion of the blood to the slow-drop method. The slow-drop infusion of saline and glucose solutions was first suggested by Friedemann<sup>9</sup> in 1913. He has used this method continuously for over 20 years and has published a number of papers on this subject. The slow-drop infusion was popularized in this country by Hyman and his coworkers.<sup>10</sup> I consider the slow-drop infusion, which safeguards against a sudden overloading of the circulatory system, one of the most important additions to the technic of blood transfusions. This principle can be utilized only when citrated blood is used. Citrated blood through the mixture with an anti-coagulant may be introduced very slowly by the drop method without the risk of coagulation of the blood.

On the surgical services the majority of transfusions are given during the postoperative course in connection with the intravenous administration of glucose solution. The picture as it presents itself is usually the following. The patient has been returned to the ward and glucose solution is administered intravenously by the drop method. In fact, the intravenous glucose infusion usually has been started in the operating room. I use this method in practically every major abdominal operation, as soon as the patient reaches the operating room. The patient is then returned to the ward with the infusion apparatus in place. Whenever blood transfusion is indicated,

the glucose solution in the glass container is replaced by citrated blood. After the desired quantity of blood has been given, the intravenous administration of glucose solution is continued. Sometimes this procedure is repeated, blood being given again six or 12 hours later (and if necessary even at shorter intervals). In many instances the patient is not aware of the seriousness of his condition and does not know that a blood transfusion is being given. The citrate technic is the only procedure which allows us to change from one method (blood) to the other (glucose) with the greatest ease, as the exigencies of the case demand.

The sudden increase in the number of transfusions, since a safe method for the prevention of chills was introduced, is possibly partly due to lax indications. As blood transfusion may be given now without any discomfort to the patient, it is tempting to order transfusions without definite indications. I would like to sound a note of warning against indiscriminate use of blood transfusion which may not only be harmful to the patient, but would bring discredit to the method.

It is gratifying to see how the citrate method of blood transfusion has gradually overcome all the strenuous opposition which it encountered in its earlier years. It has traveled across the ocean and is now used even in small communities as far removed from us as Siberia. It has long been proved that citrated blood is absolutely harmless and may be used in any disease in which transfusion is indicated. With the present technic of the preparation of instruments and solutions the chills have been practically eliminated.

Bull<sup>11</sup> stated recently "In a review of methods the place of honor unquestionably belongs to the citrate method of Lewisohn which has the longest record of accomplishment. This it owes to widespread use and to its technical simplicity which adds it to the armamentarium of any doctor who can introduce a needle into a vein accurately and carry out a few simple directions."

#### REFERENCES

- <sup>1</sup> Lindeman, E. Simple Syringe Transfusion with Special Cannulas. *Am J Dis Child*, 6, 28, 1913.
- <sup>2</sup> Kimpton, A. R., and Brown, J. H. A New and Simple Method of Transfusion. *J A M A*, 61, 117, 1913.
- <sup>3</sup> Unger, L. J. A New Method of Syringe Transfusion. *J A M A*, 64, 582, 1915.
- <sup>4</sup> Lewisohn, R. A New and Greatly Simplified Method of Blood Transfusion. *Med Rec*, New York, 87, 141, 1915.
- <sup>5</sup> Lewisohn, R., and Rosenthal, N. Prevention of Chills following Transfusion of Citrated Blood. *J A M A*, 100, 466, 1933.
- <sup>6</sup> Elser, W. J., and Stillman, J. The Fetish of Triply Distilled Water. *J A M A*, 100, 1326, 1933.
- <sup>7</sup> Filatov, A., Blinov, N., and Doepp, M. Die nach Bluttransfusion auftretende nicht spezifische Proteinreaktion und deren Verhuetung. *Arch f klin Chir*, 184, 647, 1936.
- <sup>8</sup> Hirsch, S. Improved Blood Transfusion Apparatus. *ANNALS OF SURGERY*, 101, 813, 1935.

- <sup>9</sup> Friedemann, M Ueber Intravenoese Dauertropfinfusion Munchen med Wchnschr, 60, 1022, 1913
- <sup>10</sup> Hirshfeld, S, Hyman, H T, and Wanger, Justine J Influence of Velocity on the Response to Intravenous Injections Arch Int Med, 47, 259, 1931
- <sup>11</sup> Bull, D C Transfusion of Blood Nelson's Loose-Leaf Surgery, 1, 827, 1932

DISCUSSION —DR WILLIAM DEW ANDRUS (New York) reported some of the statistics of transfusion from New York Hospital In one section of 65 beds, in a period from September, 1934, to 1936, 634 transfusions were given with 13 reactions There was at least one case of aplastic anemia The method used was that described by Doctor Lewisohn, and the citrate solution was prepared in Doctor Elser's laboratory In addition, Doctor Andrus spoke of two individual cases who had received a long series of transfusions One was a case of Streptococcus septicemia in which 37 small repeated transfusions were employed, with two reactions The other case was a boy with hemolytic Staphylococcus osteomyelitis and septicemia In a period of several months he received 86 blood transfusions with two reactions

DR FRANK B BERRY (New York) said that although nearly everyone was familiar with the work that Doctor Lewisohn had done and the very brilliant results that could unquestionably be obtained with the citrate method, nevertheless there are certain instances in which it is not possible to have control of the preparation of the solution so that the more direct methods were indicated

DR R S MUELLER (Bellevue Hospital, New York) expressed his preference for the direct method of blood transfusion for the following reasons First, the blood in the direct method is out of the body for only ten or 15 minutes, during which time it comes in contact only with the glass and metal syringe which are invariably washed out after each use With the indirect method, the blood is out of the body a considerably longer time, temperature changes can take place, a chemical mixing occurs with the blood, there is a rubber tube, and the blood has to be sterile A second reason for favoring the direct method is that in cardiac cases on the medical and surgical services, and in transfusions during operation, it is possible to feel one's way along, that is, with the direct method one can give as little or as much as desired Moreover, by using the Lindeman needle, part may be given before operation and, by leaving the needle in during the operation, an additional amount, if required, may be given after the operation

DR CONDUCT W CUTLER, JR (New York) said that although his immediate association with the method and results of transfusion has been only that of the general surgeon, nevertheless he had been very much interested in the preparation of intravenous solutions, having taken up this problem three years ago at a time when, in Roosevelt Hospital, a great many chills were occurring not only from intravenous blood transfusions but from the intravenous injection of other solutions Following the brilliant work of Doctor Lewisohn, he undertook to find some solution of this problem at Roosevelt Hospital, and a method was instituted which involved careful distillation of the water, accepting the dictum that undistilled water was most likely the source of the reactions Furthermore, a careful, uniform technic of preparation of the tubing and glass was adopted, as was the use of an infusion set These methods were followed by a reduction of infusion reactions from 18 or 20 per cent to less than 0.3 per cent It has not been possible even yet to get the result desired Infusion reactions should be entirely eliminated One

hampering feature was being unable to obtain a triple still so that it was necessary to resort to the use of baffle plates installed in the old still, which is not ideal even though a real improvement.

The chill reactions as applied both to transfusion and infusion may occur from other factors than simply undistilled water. Two rather interesting instances illustrate this. It was felt that very satisfactory results were being obtained when, all at once, there developed 11 infusion chills. A check up investigation revealed the fact that the granular salt was coming from the drug room. The method of handling it there was investigated and it was discovered that a metal cup was being used for measuring both salt and boric acid crystals. As soon as that was stopped and the measuring of salt was transferred to the department's preparation room, reactions ceased.

Lately, however, several reactions occurred for which it was impossible, for a time, to ascribe a reason. On thorough investigation, it was learned that someone had succeeded in selling to the hospital the idea that there is a certain type of rubber tubing which does not need preparation. This had been employed without Doctor Cutler's knowledge. As soon as the use of this tubing, that had not been prepared with sodium hydroxide, as was previously the custom, was discontinued and new tubing was subjected to sodium hydroxide, the difficulties were momentarily at an end.

Doctor Cutler stressed the importance, also, of using thoroughly distilled rather than imperfectly distilled water. Within the past five or six days, he said, in the midst of a very satisfactory record and a continuation of the process that had been developed, transfusion chill reactions again occurred which were traced down only with considerable difficulty. Every part of the technic was checked over and over without revealing the flaw. Then a specific investigation was undertaken of the still and the baffle plates, and, finally, inquiry was made into the condenser. Thereupon it was discovered that in the reorganization of the system the condenser had not been taken down. This was immediately done and the coil removed. It was found that there was a leak permitting undistilled water from the jacket to penetrate the tube that carried the distillate. Certainly an experience of this kind points out the necessity of keeping the distillate free of undistilled water.

DR HOWARD LILIENTHAL (New York) referred to the important matter of rapid or slow introduction of blood or fluid, particularly of blood. This depends, he said, entirely upon the nature of the conditions that call for transfusion. When a disease is accompanied by anemia, slow transfusion is best. But in the case of a healthy person who has been operated upon with the loss of a large quantity of blood, this should be replaced as rapidly as possible. Tremendous credit for the kind of work that has been done at Mt Sinai Hospital belongs to Doctor Rosenthal. Whereas, formerly there was a certain percentage of reactions, since the establishment by Doctor Rosenthal of a central department for making and preparing solutions, the absence of reactions has become pronounced. This department takes care of the preparation of apparatus as well as of solutions.

DR PAUL C. MORTON (New York) reported that, in 1930, similar difficulties had occurred at St. Luke's as occurred two years later at Roosevelt Hospital. At that time the general principles given by Doctor Lewisoohn were followed. After two years' investigation and experimentation, in 1932 a special room was equipped for the preparation of intravenous solutions and equipment. A few minor modifications were made in the Mt Sinai technic, such as an increase in the size of the metal box, an increase in the size of the gravity flask, and separation of the clysis sets from the infusion sets. The

general technic of rubber, and solution preparation, remained the same. During the four year period, from 1932 to 1936, 11,173 infusions have been given, with nine reactions, eight of which occurred in a period of four months, the source of contamination having been in a gelatin seal which covered the glucose ampule cap. Whenever any of this gelatin seal fell into the gravity flask a reaction occurred, and as soon as the technic of adding glucose to the solution was changed, and double-tipped glass ampules used, reactions ceased.

Four months ago, however, one other chill was encountered, following an intravenous treatment. It has seemed impossible to determine the cause of this reaction. It has been the experience at St. Luke's that whenever a reaction occurs, it can be traced back to some break in technic, the chills and reactions being due to a foreign protein entering the system through a direct contamination, as noted above, through improperly distilled water, or through improperly prepared rubber tubing. Experiments in Doctor Morton's hands have shown that improperly prepared rubber tubing will produce chills. It is felt now that triple distilled water is not essential, but that great care should be used in keeping the still clean and in having a high boiling chamber and adequate baffle plates. When this is done consistently good results following Doctor Lewisohn's technic, either in blood transfusions or in the introduction of fluids intravenously, can be expected.

In Doctor Morton's experience, hydrogen ion concentration has played no part in the production of chills. Neither has temperature of the solution. Speed shock has not been encountered, intravenous solutions having been given as rapidly as 1,000 cc. in ten minutes, and as slowly as the drip method can supply the liquid without having the blood clot. No chill has been dependent upon this factor. Neither has concentration of the solution produced chills. As much as 200 cc. of 20 per cent salt solution, 50 per cent glucose solution in plain distilled water, has been given without untoward effect.

In reference to the sale of commercially prepared solutions for intravenous use, Doctor Morton said that at various times members of the staff at St. Luke's Hospital have been interviewed by all the companies making commercial solutions. In spite of the greatest confidence in the chemical purity of the product, experiences at St. Luke's do not concur with the statements of those who claim that they have not encountered chills and reactions with such solutions. The uncontrollable factor in these preparations lies in the rubber tubing through which the solution is given. The original tubing as distributed with the sets is adequately prepared, but, following its initial use, it is used over and over again with other flasks, and is, in the greatest majority of cases, inadequately prepared, so that it proves to be a source of contamination and constitutes the great danger that lies in the use of commercial transfusion preparations.

DOCTOR LEWISOHN (closing) stated that he was surprised to hear that a number of hospitals in this city still use the syringe method, in spite of the fact that the citrate method is simpler and safer. It might be of interest to point out that the Lahey and Mayo Clinics use the citrate method, with the same good clinical results and the same low incidence of chills as reported at Mt. Sinai and other hospitals using the citrate method.

# FATTY ACID SOLUTIONS FOR THE INJECTION TREATMENT OF VARICOSE VEINS

## EVALUATION OF FOUR NEW SOLUTIONS

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FROM THE VARICOSE VEIN CLINICS OF THE STUYVESANT POLYCLINIC AND LETH BRIDGES HOSPITALS, NEW YORK

SCLEROSIVE therapy by the injection method has developed a new phase. The search for an ideal solution has resulted in the submission of a new group of obliterative agents, the results of the employment of which forms the basis of this communication.

In 1933,<sup>1</sup> the polyglut mixture known as sodium morrhuate was evaluated and it was pointed out that a more perfect solution could be derived from this source by the isolation of the proper fatty acid compound. The sclerosing action of sodium oleate, which is one of the chief constituents of sodium morrhuate, was also described. Following this investigation, a number of chemists attacked the problem of isolating the active ingredients in the older preparations.

The four new solutions herewith described are the result of this research and all contain fatty acids. It is felt that a definite advance has been made in the fact that these newer tissue irritants are toward the fatty acid group. It has long been considered that there is no particular virtue in any one sclerosing solution. The pathology following obliterative therapy is of the same general type in all cases and depends upon the degree of irritation, rather than upon any peculiar chemical action. It follows, therefore, that the solution of choice would be one that resembles the natural body humors. Fatty acid salt solutions are normally found in the body as a result of digestion, being formed in the intestinal villi by the saponification of ingested fats. In high concentration these solutions are irritating to the tissues and therefore become ideal sclerosing agents.

Before describing the new solutions, it may be well to recall their chemical background. The parent compound, sodium morrhuate, is a mixture of the fatty acid salts derived from cod liver oil by saponification. It is really a liquid soap solution, in other words, a cod liver oil soap. It is important to keep these facts in mind during the following discussion.

MORU-QUIN — This preparation is a combination of the two most widely used preparations, namely, sodium morrhuate and quinine. It is made in two strengths. Moru-Quin A contains sodium morrhuate 5 per cent, quinine alkaloid 2 per cent, and benzyl alcohol, Moru-Quin B contains sodium morrhuate 10 per cent and 2 per cent of the other two ingredients. The concentration of quinine in either mixture is only 2 per cent as contrasted



with 13 per cent in the older preparation of quinine and urethane. The important ingredient, therefore, is the sodium morrhuate. I have never observed any "quinine effect" from the use of this solution in ordinary quantities. It has been claimed that this is due to the formation of a loose chemical combination called "quinine morrhuate." However, the low concentration of quinine in the preparation is the more probable answer.

Moru-Quin B, the 10 per cent solution, is of a syrupy consistency, which makes it difficult to use. I have found little occasion to employ this molasses like mixture, although in occasional stubborn cases it has produced sclerosis where the 5 per cent mixture failed.

Moru-Quin A was first personally employed in November, 1933. In the past two and one-half years, it has been used 750 times. In sclerosive efficiency it stands a little higher than plain sodium morrhuate (Table I). The solution, on standing, becomes turbid but clears on gentle warming. There is no cramp following injection. Accidental perivascular injection may produce sloughing a little more readily than is the case with plain sodium morrhuate. However, it is definitely less prone to cause tissue necrosis than ordinary quinine and urethane.

I find that Moru-Quin is a definite addition to our armamentarium. It is especially useful in preparing the patient for quinine therapy. By its use a quinine idiosyncrasy may be detected and a tolerance built up to avoid cinchonism. It is, therefore, a good stepping stone toward the use of plain quinine when this reagent is indicated.

In the modern treatment of varicose veins a variety of solutions are necessary. Due to the frequent presence of latent phlebitis, it is necessary to begin with a weak solution and work up towards a more irritant preparation.<sup>2</sup> By carefully increasing the irritating action of the therapy it is possible to avoid severe migrating reactions. With a greater variety of sclerosing solutions the modern operator has an increasing flexibility of technique and can more carefully control his results. Moru-Quin, despite the few advantages it possesses, fills a useful niche midway between the weaker and stronger members of the endothelial irritants.

**OLEATE QUININE**—This preparation, which I have used 400 times in the past two years, is a mixture of 5 per cent potassium oleate, 2 per cent quinine alkaloid, and 2 per cent benzyl alcohol in water. The formula is definite and unvarying. There is no clouding of the solution even after prolonged standing. The average injection of 2 cc causes a firm thrombosis in over 90 per cent of cases.

Clinically, its sclerosive action is as uniform as its formula. Again no "quinine effect" results because of its low concentration in the mixture. Due to the irritating qualities of the solution, it should never be employed at the outset of a case. There is no cramping upon injection and clinically I have not observed any allergic reactions.

From the cosmetic point of view it must be employed cautiously. It

is of such an irritant nature that it often excites pigmentation over the affected vein, and is also apt to cause bulky nodular thromboses which absorb slowly. Its sclerosive efficiency, as shown in Table I, is slightly less than that of quinine and urethane, and it is also less likely to cause a slough formation than this older preparation.

Oleate Quinine is extremely useful as a routine solution. It has a constant, dependable sclerosive action, and is a definite improvement over the morrhuate type of solution.

**SYLNASOL**—My interest in this solution dates from March, 1935, when the preparation known as sodium psylliate was offered to me for testing purposes. This solution, containing the sodium salts of the fatty acids derived from the psyllium seed oil, at first acted like a weak substitute for sodium morrhuate. Subsequent improvement resulted in a more stable and efficient preparation which is now marketed under the name of Sylnasol.

Before putting Sylnasol to wide clinical usage, it was necessary to study its toxicity. Laboratory tests disclosed the fact that adult white rats could tolerate  $1\frac{1}{4}$  cc of sodium psylliate intravenously without ill effects, except for temporarily labored respirations. This corresponds to 450 cc in human beings weighing 60 kilos. Obviously, there is a wide margin of safety with the use of this reagent.

Further studies were then made of the hemolytic action of Sylnasol in comparison with two allied solutions, sodium morrhuate and sodium resmoleate. The materials used in the test were a 5 per cent suspension of whole human blood in normal saline solution and varying dilutions of the drugs with normal saline. It was concluded from this study that Sylnasol was less hemolytic in all dilutions than sodium morrhuate. It was also observed that sodium resmoleate in the stronger solutions hemolyzed the corpuscles more rapidly than sodium morrhuate or Sylnasol. It is evident that Sylnasol is a comparatively safe solution for clinical use.

Clinically, Sylnasol has been used by me 800 times in the past year. It is less irritating than sodium morrhuate (Table I). I have never observed any definite dermatitis arising from its use. There have been occasional cases who complained of arthritic pains during the course of Sylnasol therapy. This symptom has also been observed with other fatty acid salt solutions, and is indeed a puzzling phenomenon. It must be remembered that the age group of various veins coincides with that of arthritis and that joint pains complained of during therapy may well be coincidental. The problem needs continued study before any definite answer may be attempted.

The mode of action of fatty acid preparations forms an interesting problem. It has been held that there is a relationship between the hemolytic action and the sclerosing effect. However, the fact that so many fatty acid salt solutions of varying hemolytic power are sclerosive in nature indicates another type of action. Experimentally, I have found that ordinary commercial liquid soap also has sclerosive power. It is well known that soap lowers sur-

face tension This "soap effect" may be one of the factors in the mechanism of thrombosis with this type of solution

A curious but comparatively rare occurrence with Sylnasol is the appearance of a throbbing, pulse like pain in the region of the loin immediately following injection This occurs more readily on the left side and is apparently due to renal irritation It is an alarming but transitory phenomenon, generally disappearing within 15 minutes In the few cases that have complained of this peculiar pain, I have been able to reproduce it with subsequent injections Patients exhibiting this idiosyncrasy should be changed to another solution

In varicose veins Sylnasol fills an important need for a mild irritant, especially in cases of phlebitis It is the safest of the newer fatty acid preparations, and I have never observed any slough following its use It causes no cramping and resembles morrhuate in the type of thrombosis produced It has, in my opinion, a definite sphere of usefulness in the obliterative therapy of varicose veins Its place in the family of chemical irritants is shown in Table I

MONOETHANOLAMINE OLEATE—This solution is the result of the last few years of investigation for the ideal obliterative agent It is an oleate similar to the sodium oleate I employed for varicose veins in 1933 It contains an organic base combined with oleic acid, and is thus a definite chemical compound that can always be prepared in batches which are perfectly comparable In this way it overcomes the main objection to sodium morrhuate and Sylnasol which vary from batch to batch

Monoethanolamine oleate is a pale amber solution that remains clear indefinitely without losing its sclerosive potency Its formula is  $C_{17}H_{33}COONH_3CH_2CH_2OH$

Pharmacologic tests show that the MLD intravenously in rabbits constantly runs 130 mg per kg This is in contrast to sodium morrhuate which varies from 100 to 125 mg per kg, so that it is somewhat less toxic than sodium morrhuate I have never observed any toxic effects from the clinical use of this solution in an experience of 500 injections There is no pain or cramping on injection Perivascular accident is only productive of slight discomfort, and sloughing will probably be a rarity because no necrosis has as yet been observed in my series of extravascular injections

As shown in Table I, its efficiency as a sclerosive agent is very high, ranking next to quinine and urethane when used in similar quantities In larger amounts, it surpasses quinine in efficiency because it may be used in 5 cc quantities, while quinine is rarely used in amounts over 3 cc The thrombi produced are as firm as those following quinine therapy Pigmentation sometimes occurs in brunettes if the reaction is pronounced As an efficient non-toxic, dependable vascular sclerosive agent, there has been nothing in my experience which surpasses monoethanolamine oleate

From the allergic viewpoint, little of a definite nature can be stated, except that I have never observed dermatitis of the "morrhuate" type following the

use of monoethanolamine oleate. The problem of fatty acid salt injections in relation to dermatitis is as yet confused. The work of Jordan, *et al*,<sup>3</sup> shows that soaps in dilute solution cause a dermatitis after patch testing in approximately 50 per cent of individuals. This proportion is higher in patients with other forms of allergy, probably as a result of polysensitivity. These workers found that the alkali content of soap solutions is of minor importance in this respect.

It is clear that soap solutions in contact with epidermis often cause dermatitis, monoethanolamine oleate, being a soap, will also behave in this manner. However, there should be no skin contact with correct intravenous therapy. Furthermore, in the circulating blood stream, the fatty acids are altered, as has been amply proved, prior to oxidation or absorption. Theoretically, therefore, there should be no dermatitis following the careful intravenous use of this solution. Practically, as has been stated above, no allergic dermatitis has been noted. This reasoning does not apply in the case of sodium morrhuate because of the probable presence of a protein fraction normally found in cod liver oil.

Monoethanolamine oleate, up to the present time, stands out as more closely approaching the ideal endothelial irritant than any other solution in use.

TABLE I  
ORDER OF INCREASING SCLEROTIC POWER

Solution	Classification	Amount Injected	Untoward Reactions	Indication
1 Dextrose	Organic	2-20 cc	None	Latent phlebitis
2 Invert Sugar	Organic	2-20 cc	Cramp only occasionally	Phlebitis and routinely as first injection
3 Sodium Chloride 20%	Dehydrant	5-20 cc	Cramp	Dilated venules for smooth thrombosis
4 Dextrose and Na Cl	Mixed	5-20 cc	Cramp	Where smooth cosmetic result is desired in varicose veins
5 Sylnasol, 5% and 10%	Soap	2-5 cc	Renal colic	Varicose veins
6 Sodium Morrhuate	Soap	2-10 cc	Dermatitis	Varicose veins
7 Moru-Quin A	Mixed	2-5 cc	Occasional dermatitis	Varicose veins
8 Oleate Quinine	Mixed	2-3 cc	Pigmentation	Varicose veins, resistant veins
9 Monoethanolamine Oleate	Soap	1-3 cc	None	Varicose veins, resistant veins
10 Quinine and Urethane	Organic	1-3 cc	Cinchonism, pigmentation	Varicose veins, resistant veins
11 Sodium Salicylate 30 to 40%	Dehydrant	1-3 cc	Intense cramp	Resistant veins
12 Bichloride of Mercury 1%	Heavy metal	½-1 cc	Pain, hydragrya	Rarely used, except in stubborn sclerotic varicose veins

CONCLUSIONS

- (1) Four new fatty acid solutions are presented
- (2) Mouri-Quin, a loose chemical combination of sodium morrhuate and quinine, is a useful new solution
- (3) Oleate Quinine, combining potassium oleate and quinine in one solution, is a stable mixture with uniform sclerosive power
- (4) Sylnasol, containing the fatty acid salts of psyllium seed oil, resembles sodium morrhuate in its action on veins
- (5) Monoethanolamine oleate, a synthetic compound of unvarying nature, is at present the most efficient sclerosive agent for use in varicose veins
- (6) Fatty acid salt solutions are an advance toward safer and more efficient sclerosive therapy

REFERENCES

- <sup>1</sup> Biegeleisen, Hyman The Evaluation of Sodium Morrhuate Therapy in Varicose Veins, a Critical Study Surg, Gynec and Obstet, 57, 696-700, November, 1933
- <sup>2</sup> Biegeleisen, H I The Treatment of Phlebitis in Varicose Veins Lancet, 230, 944-946, April 25, 1936
- <sup>3</sup> Jordon, *et al* Studies in the Eczematizing Properties of Soaps New York State J Med, 791, May 15, 1936

# VITAMIN C DEFICIENCY AND WOUND HEALING

## AN EXPERIMENTAL AND CLINICAL STUDY

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SPONTANEOUS breakdown of a surgical wound in the absence of infection occurs with relative frequency in patients with the cachexia of cancer, in debilitated individuals, and in young patients, notably those who have some congenital anomaly of the gastro-intestinal tract. There exists in these patients a likelihood of ascorbic acid deficiency. Since the relationship of ascorbic acid to collagen formation has been clearly demonstrated, we have endeavored to reexamine the problem of noninfectious wound breakdown from the point of view of a possible specific relationship to vitamin C deficiency.

Cases of frank scurvy are not of frequent occurrence even in patients of the age group treated at the Children's and Infants' Hospital in Boston. There is being disclosed at this hospital by laboratory tests, however, a far greater incidence of asymptomatic scurvy than hitherto could be recognized by the usual methods of clinical examination. The term "asymptomatic scurvy" may be defined as scurvy existing in a patient without characteristic symptoms, physical signs, or roentgenologic evidence during life, but in whom the histologic changes of early scurvy are demonstrable at autopsy, as is illustrated in the appended case report.

**Case Report**—No A204,665, L F, male, age four weeks, was admitted to the hospital because of a congenital atresia of the bowel. He had had an ileostomy performed at another hospital at the age of two days. On admission he was markedly emaciated and dehydrated. For ten days an attempt was made to improve his nutritional state. In addition to breast milk, he was given several transfusions, and daily administrations of parenteral fluids—glucose and normal saline. On the eleventh day a laparotomy was performed, and a side-to-side anastomosis around the site of the obstruction effected. The ileostomy was closed. For the next three days the patient received a continuous intravenous drip of glucose, as well as two transfusions. The abdominal wound opened on the third postoperative day. It was resutured but the patient died the following day.

At autopsy microscopic sections of the costochondral junction were described as follows: "There is a definite lattice formation and many of the cartilage spicules are fractured. Osteoblasts are present along the cartilage spicules but there is no osteoid formation." This is evidence of early scurvy. It is significant that roentgenologic examination of the wrist, taken during life, showed no evidence of scurvy. It is also suggestive, in view of our experimental findings, that sections of the skin at the operative site showed numerous fibroblasts without formation of collagen. Sections of the

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intestinal wall adjacent to the anastomosis showed proliferation of connective tissue without definite formation of collagen

This infant had asymptomatic scurvy at six weeks of age, but during life did not show any of the clinical or roentgenologic evidences of the disease. Although this patient received some breast milk during his six weeks of life, it seems clear that he did not have enough ascorbic acid to meet metabolic requirements. It is our opinion that this was at least one factor in the failure of the wound to heal.

Minot<sup>1</sup> (1936) has recently stated "The major problems of nutrition do not concern clean cut deficiency diseases, but the prevention of partial deficiency. Border line states of nutritional instability are much more common than is usually appreciated. There is a wide zone between optimal nutrition, and the level at which classic symptoms of recognized dietary deficient states develop." It is becoming increasingly apparent that vitamin C nutrition is a relative term embracing several zones of ascorbic acid depot, between saturation on the one hand and absolute depletion on the other. A large body of evidence is being assembled to show that the conception of vitamin C deficiency should include not only absolute depletion of the ascorbic acid stores, but also such low levels of supply as place the functioning of connective tissue cells at a physiologic disadvantage.

This conception of vitamin C deficiency, as well as the wide range of plasma ascorbic acid levels in human beings, is borne out by a recent study by one of us<sup>2</sup> at the Infants' Hospital. The ascorbic acid in the plasma was determined in 54 patients. These patients were divided into four groups on the basis of their ascorbic acid nutrition as suggested by the feeding history. The results are shown in Table I.

TABLE I

Group*	Plasma Ascorbic Acid (Mg %—Average for Group)
I Well Baby Clinic	1.00
II Ward patients with history of good vitamin C content in diet	0.73
III Ward patients with history of poor vitamin C content in diet	0.22
IV Ward patients with frank scurvy	0.08

\* It is noteworthy that only in Group IV was there clinical evidence of scurvy. Groups II and III were admitted for a great variety of causes. Group I showed no disease.

The subject of wound healing is covered by a large literature that has recently been surveyed by Arey<sup>3</sup> (1936). He lists 12 general factors influencing wound healing, each one of which has been the subject of numerous researches. Among other phases of nutrition, the influence of fats, carbohydrates, and proteins, in the diet, has been investigated. Likewise considerable attention has been given to the rôle of vitamins in regenerative

processes Avitaminosis A, B, C, and D has each in its turn been reported to inhibit normal healing, with resumption of healing following ingestion, or local application, of the specific vitamin involved in the deficiency

The attention given to local application of vitamins, hormones, peptones, chick embryo juice, and sulphhydryl compounds rests largely on the emphasis given by Carrel<sup>4</sup> (1921) to "external irritation," as the initiating mechanism of wound repair. He was able to delay cicatrization and epidermization for as long as 20 days by protecting the wound with an overlying sheet of fascia sutured to its edges. The multiplicity of specific remedies advocated for the promotion of wound healing, however, is at variance with the simple clinical fact that most wounds, not directly contaminated by gross infection, heal satisfactorily in healthy people, while those in debilitated patients may be difficult to improve under any regimen. As Hojer<sup>7</sup> (1924) has aptly put it "Even if, as Carrel has pointed out, the cicatrization of wounds is apparently initiated by an external factor, the answer of the organism to the irritation is decided by internal factors." He concludes that a full supply of antiscorbutic "is necessary to an answer of normal intensity."

Normal repair of connective tissue is primarily a process of fibroblastic proliferation and the formation of collagen. Wolbach<sup>5</sup> (1933) has concluded that this formation of collagen is "a product of secretory activity of fibroblasts."

Wolbach and Howe<sup>6</sup> (1926) have characterized scurvy as an "inability of the supporting tissues to produce and maintain intercellular substance. Direct proof of this conclusion has been obtained in the study of repair of soft tissue in regard to the collagen of connective tissue." Hojer has observed that "Before the formation of collagen is completely arrested, there is a stage where it is very unevenly distributed and irregularly arranged."

These facts rest securely upon proved pathologic studies and form the basis for an experimental study of wound healing in guinea-pigs, which were partially depleted of their vitamin C depot and subsequently maintained at a low level of ascorbic acid supply (0.25 mg daily). The nutritional state of these animals resulting from this diet may be held analogous to asymptomatic scurvy.

*Experiments*—During this study two groups, comprising normal and scorbutic guinea-pigs, were operated upon and incisions made through the abdominal and stomach wall. Subsequently at periods of ten, 20, and 30 days, representatives of each group were sacrificed for histologic study, and for the measurement of the pressure required to rupture the scars in the abdominal and gastric walls.

*Diet*—Twenty-four growing guinea-pigs weighing about 200 Gm were separated in two groups, one group was fed solely on a scorbutogenic diet, and the other on this same basic formula but with an ample supplement of green vegetable tops.



## WOUND HEALING

Rolled oats	35 0%	35 0%
Wheaten bran	34 0%	34 0%
Skimmed milk powder (heated and stirred for 1 hr )	22 5%	
Butter fat	7 5%	
Sodium chloride	1 0%	1 0%

In addition 0.5 cc of oleum percomorphum (for vitamins A and D) was given twice a week

The group selected for the production of scurvy was given the above diet exclusively for nine days in order to accomplish, to a large degree, depletion of the vitamin C depot. On the tenth day 20 mg of crystalline ascorbic acid dissolved in distilled water were administered with a pipet to each of these 12 guinea-pigs. Thereafter 0.5 mg was given every other day for the duration of the experiment.

The scorbutogenic properties of this diet and the adequacy of the control feeding were attested by roentgenologic studies of the wrists at ten day intervals on representatives of both groups, and by the histology of the ribs at autopsy.

*Operative Technic*—On the fifteenth day after starting the above diets, the 12 scorbutic and the 12 normal animals were operated upon as follows. Under ether and using aseptic technic, a one inch incision was made slightly below the xiphoid in the midline, the abdominal musculature divided by blunt dissection, and the peritoneum incised. The stomach was delivered into the wound and part of the anterior stomach wall was placed in an intestinal clamp. An incision one-half inch long was then made through the anterior stomach wall. This incision was closed with a running suture of silk, no attempt being made to invert the edges. The abdominal wound was closed in two layers, interrupted silk sutures to muscles and peritoneum, and the skin by a running suture of silk. No dressing was applied to the skin, which was cleaned with alcohol and painted with collodion.

In the scorbutic group there was one immediate operative fatality, and a second guinea-pig died during the night following operation. Two of the controls were found unsatisfactory for the purpose of this experiment, one because of gross infection of the wound and healing by second intention, and another because of faulty technic during measurement of wound strength. There were left ten guinea-pigs of each group (20 in all), for the purpose of the study.

*Subsequent Procedure*—The skin sutures in both groups were removed one week after operation. At periods of ten, 20, and 30 days, three members of each group were sacrificed, two for the purpose of wound measurement, and the third for histologic study.

There were no complicating factors in the experiment as far as could be ascertained. The wounds healed by first intention and at about the same gross rate. The smooth, even abdominal scars of the normally fed group, however, at ten, 20, and 30 days postoperatively, contrasted with the rough

appearance of the scars of the scorbutic group at the same time interval (Fig 1)

*Technic of Measurement*—As in the experiments of Harvey and Howes<sup>8</sup> (1930), the strength of the wound was estimated in terms of its breaking point when distended by air. Our apparatus differed from theirs, however, and was constructed from a mercury sphygmomanometer with its cuff wrapped around a small bottle. Its closed circuit was connected with a free length of tubing to which a lumbar puncture needle was attached (Fig 2). The needle was inserted into the peritoneal cavity, care being taken to avoid subcutaneous emphysema, and the intra-abdominal pressure slowly increased. The highest point reached by the mercury column, before gaping and rupture of the wound occurred, was recorded. The same general procedure was used



FIG 1—The normal animal is on the left. Note difference in gross appearance of operative wounds. (Ten days postoperative.)

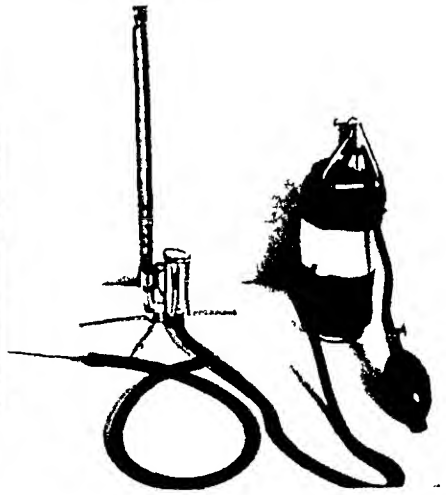


FIG 2—Apparatus used for distending wounds in the experimental animals.

for testing the stomach wound. The organs were left in situ after opening the abdominal wall. The esophagus was clamped close to the cardia, the small intestine tied about one inch below the pylorus, and the needle inserted just proximal to this tie. We may quote Harvey and Howes in regard to the accuracy of this method of measuring wound strength: "It is conceded at once that this gives no value of the (absolute) strength of the wound, but inasmuch as the data desired, are those of relative changes in strength, the method seems adequate."

*Results*—During the process of abdominal distention and rupture, there was a characteristic gross difference in tensile strength, behavior, and appearance of the two types of wounds. The abdominal wounds of the normal animals uniformly withstood far greater distending pressure than did those of the scorbutic animals. The wounds of the normal animals burst with great suddenness when they reached the breaking point, the wounds of the scorbutic animals first gaped widely at the site of the incision, and then ruptured at a slightly higher pressure. The scar tissue of the wounds of the normal animals after rupture was pink and firm, while that of the wounds

of the scorbutic animals was livid and of soft consistency. It resembled closely the appearance of the broken down wound in the debilitated human patient (Figs 3 and 4).

It was found that the wound in the abdominal wall served better to demonstrate the difference in wound strength of the two groups, as the wound in the stomach was not always suitable for direct observation. In addition, the gastric incisions with their subsequent adhesions to liver and omentum were not precisely similar in each guinea-pig. It is notable, however, that in all the scorbutic animals rupture occurred at the wound, while in the normal animals the stomach ruptured in all cases elsewhere than at the wound, and at higher levels of pressure (Tables II and III).



FIG 3—Same animals as in Fig 1, 30 days postoperative. The peritoneal cavity of the normal animal on the left has been distended to 70 Mm of mercury air pressure. The scorbutic animal on the right is distended to only 38 Mm of mercury air pressure, and the wound has begun to gape.

FIG 4—Same animals as Figs 1 and 2. The normal animal on the left is now distended to 200 Mm of mercury air pressure. The wound has ruptured. The animal on the right is distended to 47 Mm of mercury air pressure and complete rupture of the wound has occurred. Note difference in gross appearance of both wound edges and the granulation tissue in the two animals.

*Histology*—Sections were made through three representative areas of each wound, and stained with hematoxylin and eosin, and with Mallory's aniline blue.

The operative incision through the corium in each of the partially scorbutic animals showed connective tissue repair with but very little collagen production. A defect in the corium resulted that was easily apparent under low magnification (Fig 5). The subcutaneous fibroblastic tissue was abnormally thick and irregular in pattern in the partially scorbutic animals, and there was very little collagen deposition ten, 20, and 30 days postoperatively (Fig 6). Numerous extravasations of red blood cells were seen, in many of which were strands of fibrin. Hemosiderin was conspicuous in the two animals sacrificed 20 and 30 days after operation. In all control animals there was a thick collagenous layer at the site of the incision, and the original point of incision through the corium could be ascertained only by its relation to the subcutaneous scar. Healing in the controls proceeded with a plentiful

TABLE II

AIR PRESSURE REQUIRED (IN MILLIMETERS OF MERCURY) TO RUPTURE ABDOMINAL WOUNDS

Normal Animals				Scorbutic Animals			
Number	Date	Mm of Mercury		Number	Date	Mm of Mercury	
		Gaped	Ruptured			Gaped	Ruptured
1	10 days P O		128	1	10 days P O	67	85
2	10 days P O		145	2	10 days P O	37	60
3	20 days P O		165	3	20 days P O	40	50
4	20 days P O		135*	4	20 days P O	45	65
5	30 days P O		210†	5	30 days P O	62	85
6	30 days P O		200	6	30 days P O	38	47
	Average		160		Average	48	65

\* Postoperative hernia

† Abdominal wall ruptured elsewhere before wound gave way

TABLE III

AIR PRESSURE REQUIRED (IN MILLIMETERS OF MERCURY) TO RUPTURE GASTRIC WOUNDS

Normal Animals			Scorbutic Animals		
Number	Date	Mm of Hg	Number	Date	Mm of Hg
1	10 Days P O	95	1	10 Days P O	25
2	10 Days P O	90	2	10 Days P O	34
3	20 Days P O	60	3	20 Days P O	20
4	20 Days P O	45	4	20 Days P O	40
5	30 Days P O	45	5	30 Days P O	25
6	30 Days P O	43	6	30 Days P O	34
	Average	70		Average	30

In all cases stomach ruptured elsewhere  
than at woundIn all cases wound ruptured before  
stomach

deposition of collagen by the tenth postoperative day, and in the wounds of these animals hemorrhage and hemosiderosis were minimal. Both groups showed foreign body giant cell reaction about the sutures.

DISCUSSION —Other workers have established experimentally the inability of tissues to produce intercellular substance in absolute scurvy. That the data so obtained have a valid application to human beings is the conclusion of Wolbach<sup>9</sup> (1937) as recently expressed in the following statement: "The gross and microscopic pathologic changes of human scurvy as seen in the infant, and experimental scurvy as seen in the guinea-pig, are so nearly identical that no reasonable doubt can be entertained with regard to applying to the human being the facts ascertained from the experimental studies." One can therefore state with a fair degree of certainty that in a patient with abso-

lute scurvy, the effective healing of such lesions as require fibroblastic repair comes to a standstill. Absolute scurvy, however, is of relatively rare occurrence. The most significant clinical aspect of this study is its possible bearing on states of partial deficiency of vitamin C.

The condition of the vitamin C deficient animals used in this study may be held analogous to asymptomatic scurvy in man. Wound healing in these partially scorbutic animals progresses in marked contrast to that observed in the controls. This contrast was manifested in inferior tensile strength, in a disposition of these wounds to gape before rupturing, and in the livid appearance of their granulation tissue and its soft consistency. Microscopic study provided what seems to be an adequate explanation for these differences. The deficiency in collagen was undoubtedly reflected in the inferior tensile strength and soft consistency of the scorbutic granulation tissue. Its lividity was probably a reflection of poor vascularization and hemorrhage.



FIG 5—Photomicrograph of skin and subcutaneous tissue of scorbutic animal, showing the defect in the corium (low power), aniline blue stain

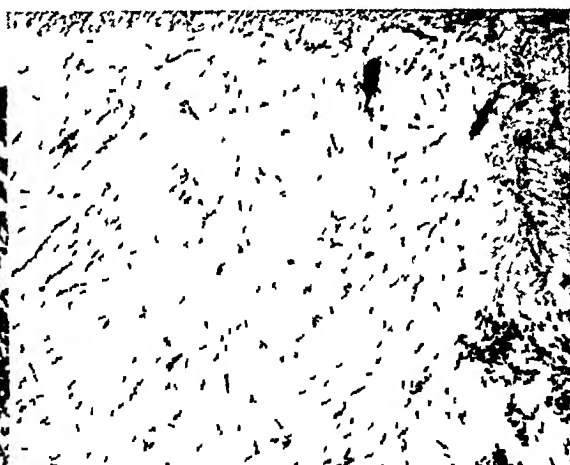


FIG 6—Photomicrograph of the subcutaneous tissues of the same animal as Fig 5, showing the great cellularity and irregular arrangement of fibroblasts, which are laying down very little intercellular substance—collagen (low power)

The initial gaping observed in the wounds of the scorbutic animals following abdominal distention can be ascribed to the defect found regularly in the corium. This defect was not seen in the control animals in which a new layer of collagen was laid down in the first ten days after operation. The importance of the corium in repair of the abdominal defect is also indicated by the fact that one normal animal with a postoperative hernia withstood an intra-abdominal pressure of 135 Mm of mercury before rupture occurred (Table II). The inferior tensile strength of the wounds of the scorbutic animals 30 days postoperatively has an added importance in the light of Harvey and Howes' demonstration that the greater part of the final tensile strength of a normal wound (as measured in the rat's stomach) is attained within ten days after operation.

Vitamin C does not, of course, play the only rôle in wound healing. Indeed its part among the other vitamins may not be the leading one. The progress in the early recognition of the several vitamin deficiency states has been reported by Blackfan<sup>10</sup> (1937). Vitamins A, B<sub>1</sub>, C and D can now

be determined by quantitative chemical tests. The individual bearing of all these vitamins on the healing process demands further study. It seems clear, however, that there exists a degree of vitamin C deficiency in human beings that is not recognizable by methods ordinarily used in physical examination. This degree of deficiency, or asymptomatic scurvy, may well have an important bearing on wound healing. The incidence of asymptomatic scurvy is undoubtedly more frequent than is generally realized. Its existence has been proved histologically and chemically in the age group encountered at this hospital. Its existence in older patients, though not yet proved, undoubtedly occurs. If the average daily intake of ascorbic acid falls below the minimal protective dose, the consequences of this increasing increment of deficiency, after depletion of the body depot, are evident.

In estimating the degree of vitamin C deficiency clinically, the plasma determination of ascorbic acid, by the indophenol test, serves as a very useful guide. When the figure falls much below 45 mg per 100 cc of plasma, it may be inferred (Table I) that the vitamin C depot is approaching dangerous depletion. In such circumstances it would seem advisable to administer about five to ten 200 mg doses of ascorbic acid, as an initial step in preparing the patient for operation. This can be given by mouth or with intravenous fluids, and should not in the least complicate or conflict with other steps that may be indicated as a part of preoperative care.

It is evident that further work on quantitative determination of plasma ascorbic acid must be done, not only in the age group here considered but more especially in adults. Further work along this line is now under way at the Children's Hospital. It is hoped that this paper may stimulate similar studies in hospitals for adults. For it seems reasonable to suppose that in older patients, such as those suffering from prolonged obstruction due to cancer of the pylorus, there may well be a dangerously low ascorbic acid depot.

**SUMMARY**—Guinea-pigs were partially depleted of their ascorbic acid depot, and were subsequently maintained on approximately one-fifth of the minimal protective daily dose of ascorbic acid. The healing of the operative incisions of these animals, both histologically and physiologically, was inferior to that of a group of control animals.

A normal wound is considered to attain the greater part of its final strength within the first ten days after operation, but the partially scorbutic animals had greatly inferior tensile strength, when compared to their controls, ten, 20, and 30 days postoperatively.

The abdominal wounds of the scorbutic group ruptured at a pressure averaging approximately one-third that required to rupture the wounds of the normal animals.

The scar tissue in these wounds was distinctly abnormal, being livid and soft in consistency. Histologic study of the wounds in the partially scorbutic group showed defective repair of the corium, and a poor production of collagen in the scar.

The clinical application of these facts is discussed, and a case in point is

cited, in which the presence of asymptomatic scurvy is thought to have been a factor in the failure of an operative wound to heal

#### CONCLUSIONS

Vitamin C plays an important rôle in the healing of experimentally produced wounds in guinea-pigs

There may exist in human beings a degree of vitamin C deficiency that cannot be recognized by methods ordinarily used in physical examination

It has been proved, histologically and chemically, that asymptomatic scurvy is far more common in infants and children than has been realized. Its existence in older patients, though not yet proved, undoubtedly occurs

Evidence is presented that a partial vitamin C deficiency is of more importance in the healing of surgical wounds in human beings than has hitherto been appreciated. When a low ascorbic acid depot in a patient is found, or suspected, the giving of ascorbic acid, as an aid to wound healing, seems amply justified

We wish to thank Dr. Sidney Farber for his help in the study and interpretation of the histopathologic data, and Dr. Otto A. Bessey for his help on the chemical and nutritional aspects of the problem

#### REFERENCES

- <sup>1</sup> Minot, G. R. Symposium on Nutrition and the Deficiency Diseases. New England Jour Med, 215, No 25, 1936
- <sup>2</sup> Ingalls, T. H. To be published 1937
- <sup>3</sup> Arey, L. B. Physiological Reviews, 16, No 3, 327, 1936
- <sup>4</sup> Carrel, A. Jour Exper Med, 34, 425, 1921
- <sup>5</sup> Wolbach, S. B. Amer Jour Path, 9, 682, 1933
- <sup>6</sup> Wolbach, S. B., and Howe, P. R. Arch Path, 1, No 1, 1926
- <sup>7</sup> Hojer, J. A. Acta Paediatrica, 111, Supplement, 1924
- <sup>8</sup> Harvey, S. C., and Howes, E. L. ANNALS OF SURGERY, 91, 641, 1930
- <sup>9</sup> Wolbach, S. B. JAMA, 108, 7, 1937
- <sup>10</sup> Blackfan, K. D. Symposium on Nutrition and the Deficiency Diseases. New England Jour Med, 215, No 25, 1936

# BRIEF COMMUNICATIONS AND CASE REPORTS

## TUBERCULOSIS OF THE STOMACH \*

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**Case Report**—J R M, age 49, when first seen complained chiefly of pain in the epigastrium which had grown gradually worse during the preceding five months. It was a burning, stinging, nonradiating pain, relieved by soda but not by food. Two weeks before admission, there had been some nausea and vomiting, but during the past seven days the patient had not been able to retain any food. He had lost ten pounds in five months.

Examination revealed tenderness over the epigastrium with definite muscular resistance. A questionable mass was palpable. The laboratory findings were: red blood cells, 4,800,000, hemoglobin 50 per cent, a gastric test meal showed no free HCl, even after the injection of histamine, and a total acidity varying from 6 to 30 in four expressions, the gastric contents were positive for blood but the feces were negative, the blood chemistry was essentially negative, and the blood Wassermann was negative. A gastro-intestinal roentgenologic examination showed that there was no deformity characteristic of a new growth, or of ulcer of the stomach or the duodenum, but there was a lack of peristalsis of the stomach, and a trace of retention at the end of six hours. The gallbladder visualization was normal. Roentgenograms of the lungs showed no pathology.

An exploratory operation was performed February 21, 1933. The stomach appeared to be thickened on both its anterior and posterior wall, suggesting a lymphatic obstruction. There was no obstruction at the duodenum. The involvement seemed to be general throughout the stomach, suggesting an infiltrating carcinoma (limitis plastica). There were numerous enlarged lymph nodes along both the greater and lesser curvatures. One along the greater curvature was removed for examination and showed tuberculosis (SC 8045). Later, tubercle bacilli were demonstrated in the lymph node. The condition was thought to be inoperable and the wound was closed.

At examination, December 19, 1934, there had been a gain of 45 pounds in weight. Gastric analysis gave findings of free HCl 4, and total acid 12. The patient stated that her appetite and digestion were excellent and that she no longer had eructations of gas.

Roentgenologic examination of the gastro-intestinal tract March 5, 1936, revealed little evidence to indicate pathology of the stomach or duodenum, except lack of peristalsis. Although peristaltic waves were seen to pass along the stomach, these were less than normal. There was, however, no gastric retention at the end of six hours, there being normal motility of the barium meal.

**DISCUSSION**—Tuberculosis of the stomach is a rare disease. Broders<sup>1</sup> reports one in 2,500 gastric operations. In the past 20 years, three cases have been presented before this Society. Edwin Beer<sup>2</sup> presented a Negro with tumefaction of the pyloric end of the stomach in 1921. At operation, he said, "on exposing the stomach, at the pyloric end and involving the antrum there was a large tumefaction about the size of an adult palm with

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\* Presented before the New York Surgical Society, March 25, 1936. Submitted for publication June 6, 1936.



many dozens of enlarged nodes along the lesser curvature and along the greater curvature. The mass in the stomach was freely movable and very firm, and gave the impression of a malignant growth." A subtotal gastrectomy was performed. On examination, the walls of the stomach were found to be thickened to 1.5 cm. The cut surface of the stomach wall was smooth, firm and dead white. There was an enormous tuberculous ulcer with an almost smooth surface which involved the whole antrum, anterior and posterior walls, beginning close to the pylorus and extending well up into the body of the stomach with innumerable nodes in the lesser and greater curvatures.

In March, 1928, Ralph Colp<sup>1</sup> presented a Negro with a solitary tuberculous ulcer of the lesser curvature with a group of caseous tuberculous lymph nodes over the ulcer site. He had entered the hospital with a history of vomiting blood, and tarry stools. Gastric analysis showed free HCl 40, total 60. Roentgenologic examination revealed a penetrating ulcer of the lesser curvature. The lung films showed a healed tuberculous process of the apices of the lungs. A subtotal resection was performed. Postoperative examination demonstrated a punched-out, indurated ulcer on the lesser curvature one and one-half inches from the cardiac orifice and one inch in diameter. In November, 1931, W. Howard Barber<sup>4</sup> presented a Negro who had entered the hospital with a history of pain after meals and vomiting for two years. A large circular ulcer was found near the pylorus, and a stomach resection was performed. Broders' case was taken for a carcinoma of the stomach until after resection. Interestingly enough, this patient had had an exploratory celiotomy elsewhere six months before, and had been closed up because he was thought to have had an inoperable carcinoma of the stomach.

Our patient belonged to the "lymphangitis" type in which the lymph channels were blocked, so that there was a thick, edematous wall throughout. No definite ulcer could be demonstrated by roentgenologic study or by palpation. Although no section of the stomach wall was taken for microscopic study, we believe that it is fair to consider this a case of tuberculosis of the stomach.

#### REFERENCES

- <sup>1</sup> Broders, A. C. *Surg. Gynec. and Obstet.*, 25, 490-504, 1917.
- <sup>2</sup> Beer, Edwin. *ANNALS OF SURGERY*, 74, 245, March, 1921.
- <sup>3</sup> Colp, Ralph. *ANNALS OF SURGERY*, 88, 311-313, 1928.
- <sup>4</sup> Barber, W. Howard. *ANNALS OF SURGERY*, 95, 259-263, 1932.

DISCUSSION.—DR. W. HOWARD BARBER (New York) remarked that the present tendency, when diagnosing tuberculosis of the stomach, is to base the diagnosis on a study of morphology and the bacteriologic findings of a given section. But, he added, Doctor Symmers will not make a definite diagnosis on morphology alone, preferring to state "either tuberculosis or syphilis" unless tubercle bacilli are actually found in the section. Doctor Barber explained that the cases referred to by Doctor White as having been reported before the New York Surgical Society by Doctors Colp, Beer, and himself had been studied morphologically but were negative bacteriologically, and were, *probably*, tuberculosis. In most instances—80 per cent—the lesions are

ulcers, but occasionally one finds tubercles. The ulcers are found in patients with tuberculosis of the lungs or gastro-intestinal tract and are chronic lesions with excavated margins and polypoid excrescences, or they are ulcers about the pylorus, with thickening, so that they cause stenosis. Broders, in 1927, reported, from the literature, 49 cases which he considered positive, because tubercle bacilli were found in the sections, he also reported 118 cases of probable tuberculosis, that is, on the basis of morphology. Doctor Symmers, however, claims that on his records at Bellevue Hospital there is not a single case of positive tuberculosis of the stomach wall. Bacilli were found in the nodes in Doctor White's case, though no section of the stomach was reported, and, in Doctor Barber's opinion, this case might fall in the group of tubercular lymphadenitis reported by Broders.

## ECHINOCOCCUS CYST OF THE LIVER IN A CHILD \*

FENWICK BEEKMAN, M D

NEW YORK

**Case Report**—A child, age 7, was admitted to the pediatric service of Bellevue Hospital, in charge of Dr. Charles Hendee Smith, December 2, 1935. Filling the upper abdomen was a large mass which caused protrusions above the umbilicus. On palpation the tumor seemed to have a distinct outline and extended from the ensiform cartilage and the costal borders down to two fingers' breadth below the umbilicus. Its surface was smooth and it appeared to spring from the anterior surface of the liver. The abdominal wall was stretched tightly over it, and there were many enlarged superficial veins beneath the skin in this region. The blood count showed 8 per cent of eosinophils. The complement fixation test was positive, as well as a skin sensitization test for echinococcus infection.

**Previous History**—She was born in Marseilles, France, of Armenian parents. For the last two years the parents had noticed that she was becoming weaker and more easily fatigued. About 18 months before admission they discovered that she had passed a round worm. They had only noticed the swelling in the abdomen for the last 15 months. A flat roentgenogram showed a distinct rounded shadow in the midline.

**Operation**—January 15, 1936, under ether anesthesia, a right paramedial incision was made extending from the costal border down to two inches below the umbilicus, the rectus muscle was retracted laterally. On opening the peritoneal cavity a large cystic mass, measuring about 8 x 15 cm, was discovered in the upper anterior portion of the abdomen. It apparently sprang from the inferior surface of the liver and extended down 8 or 9 cm below the edge of the liver. The gallbladder was found to be incorporated in the wall of the cyst on the right side and the omentum and a loop of ileum were firmly adherent to it on its left side. The inferior pole of the mass was easily delivered into the wound. The viscera about it were packed back with pads moistened with saline solution. These were covered, in turn, with other gauze pads soaked in 10 per cent formalin solution, and the mass was surrounded on the abdominal surface with gauze saturated with the same solution. The cyst was then punctured with a large aspirating needle attached to a syringe containing 10 cc of 10 per cent formalin. This was injected into the cavity of the cyst. A small part of the cystic contents was evacuated by the syringe, which was then replaced by the tube of the suction apparatus. Most of the contents were evacuated by this means. In all, the cyst held 500 cc of a cloudy, other colored fluid, of creamy consistency. When the cyst was almost emptied,

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its walls were picked up by clamps and an incision made into the cavity. The walls consisted of fibrous tissue and were about three to four Mm thick. The remaining contents of the cyst were now evacuated with the suction apparatus, which left only a white gelatinous substance which lay in the bottom of the cavity. On investigation this was found to be the entire hydatid membrane which had previously lined the fibrous capsule and was now completely separated from it and lay crumpled up in the bottom of the cavity. This was removed. The edges of the fibrous covering being held up by means of clamps, the entire cavity was filled with a solution of 10 per cent formalin, which was allowed to remain for five minutes before it was sucked out. The walls of the cyst cavity were smooth and free from hemorrhage, and were closed with a double row of chromic sutures, the first interrupted and the second continuous, so that the edges of the wound were folded in.

At no time during the procedure was there any spilling of the contents. The gauze pads were now removed and the wound in the abdominal wall was closed in layers without drainage. The child made an uneventful recovery. Since she left the hospital on February 19, 1936, she has gained weight and become much stronger.

I feel that, where it can be done, the treatment of echinococcus cyst by primary closure, as described by Roberto Alessandri, Professor of Clinical Surgery and Operative Medicine of the Royal University in Rome, is the procedure of choice.

DISCUSSION—DR RUSSEL H PATTERSON (New York) asked Doctor Beekman whether his technic is to open up the large cyst with the multiple small cysts inside like a bunch of grapes, and take out the lining of this cavity, swab it out and close it up tightly. He also asked whether this is usually easily possible.

DR SEWARD ERDMAN (New York) cited a case upon whom he had operated some seven years ago at New York Hospital, after having read Doctor Alessandri's article on the procedure, which detailed his enormous experience. Doctor Erdman said his experience had been quite similar to that of Doctor Beekman, with the use of formalin. The fibrous coat, as he understood it, properly belongs to the host, and is not part of the parasite. Therefore, that can be left, in fact, it is rather dangerous to attempt to strip it out of the liver bed for the reason that by doing so one is apt to start bleeding or open some small bile ducts. In Doctor Erdman's case, the cyst held 4,000 cc of clear fluid, the whole being larger than the bladder of a large football, and about 3 Mm thick, resembling very much the white of a hard-boiled egg, and rather brittle. The attempt was made to obliterate the cavity in the liver by closing it with sutures, bringing the sides of the fibrous walls together, but it was impossible to effect this sufficiently and, moreover, it would have left a large space with considerable oozing. It was, therefore, drained for nearly a month, ultimately closing, and the patient has remained well. The procedure followed by Doctor Beekman, instead of marsupialization, was a good one, closing the abdomen without drainage if possible.

DR THOMAS H RUSSELL (New York) said that he had had a similar case of echinococcus cyst recently, in the left lobe of the liver, which he understood to be unusual. The diagnosis was made preoperatively, due to crepitation which one could elicit. He said that he did not know exactly what to do with the cyst as he had not seen any cases operated upon before. However, after resecting the lower part of it, which was adjacent to the transverse mesocolon, and seeing that part of the wall was imbedded in it, he had to resect a large piece of the transverse colon. Then, when he tried

to remove the membrane from the liver, there was so much bleeding that he left it in, choosing to use instead an old-fashioned cautery with which he cauterized the inside of the cyst, left the cyst in, drained it, and then performed a Mickulicz procedure on the colon. Later, to his surprise, during a dressing there appeared to be a great big piece of gauze hanging out. He took hold of this and the entire wall of the cyst came out, after which, when he completed the Mickulicz procedure, he did not find any evidence of the cyst.

DR FENWICK BEEKMAN (New York), in conclusion, explained that the fibrous capsule has nothing to do with the parasite, but instead is formed by the body, due to irritation caused by the parasite, and so it is not necessary to do anything about removing it. The hydatid membrane in the patient presented looked very much like the white of a hard-boiled egg, and when removed appeared to be complete. There was only a single cyst in this case. The cases with cysts like bunches of grapes are very rare. The material removed from the cyst in the present instance was full of hooklets. Alessandro makes a point of primary closure and warns very strongly not to obliterate the cavity, because if this is attempted, one is going to open blood vessels and bile ducts so that there will be trouble later on. He believes that the cyst cavity should be washed out with 10 per cent formalin, and this was done in the case shown. The only contraindication to primary closure is where the cyst is infected in which event marsupialization becomes necessary. Doctor Beekman said he had not seen a case similar to that described by Doctor Russell.

## ACUTE PERFORATION OF A CANCEROUS GASTRIC ULCER

BRUCE L FLEMING, M D

PHILADELPHIA, PA

CARCINOMA of the stomach has a high mortality but death is rarely caused by generalized peritonitis resulting from acute perforation. Peritonitis more rarely causes death without perforation, though a few such cases have been reported. Acute perforation usually occurs with a patient at rest in bed while under observation or medical treatment for gastric carcinoma, but it is exceedingly rare for acute perforation to occur when one is actually engaged in his usual occupation. One such case has been reported by Aird.<sup>1</sup> The one herein reported is similar.

**Case Report**—E W, male, age 51, iron worker, was admitted to the Roxborough Memorial Hospital, with a diagnosis of acute perforation of a peptic ulcer. His mother had died at 60 from "cancer of the liver." Family history otherwise was irrelevant. For 15 months this patient had been troubled with gastric symptoms. A sensation of burning was the first symptom. This was usually relieved by taking food but was followed two hours after meals by hunger pains. There was never any nausea, vomiting, or aversion to food, nor did any particular kind of food aggravate the symptoms. Constipation was chronic but moderate. He had on one occasion been given medicine without relief of symptoms but no systematic regimen had ever been prescribed.

Immediately before perforation he had lost about five pounds in weight and his

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gastric symptoms were more intense but had not interfered with his occupation. On the day of perforation he had gone to work feeling well. He worked for four hours and while stooping was taken with sudden, severe, upper abdominal pain so that he was unable to straighten up. When brought to the hospital, physical examination revealed all the classical signs of an acute perforated peptic ulcer. Rectal examination revealed some fullness and tenderness in the cul-de-sac. Temperature 96.4°F. Pulse 84. Respiration 24. Blood pressure, 126/80. Blood count Hb 90 per cent, RBC 4,750,000, WBC 10,300. Urine normal. Lungs were clear and heart normal. Immediate operation was decided on.

Under gas ether anesthesia, the abdomen was opened through a right rectus incision. A perforation was found on the lesser curvature of the stomach about two inches from the pylorus. It was approximately one-quarter inch in diameter. On the serosa at the margin of the perforation was a hard, irregular, fixed nodule about one-half inch in diameter. The crater of a gastric ulcer, approximately two inches in diameter, was palpated. It was very hard. One enlarged lymph node in the lesser omentum was found and removed, and also a small section of tissue from the nodule at the margin of the perforation. It was decided that we were dealing with acute perforation of a chronic gastric ulcer which had undergone malignant degeneration. The edge of the perforation and ulcer floor was treated with the actual cautery and the opening closed by through and through suture and inversion with the stomach wall. A suprapubic drain was inserted. The patient reacted promptly and made an uneventful recovery. Dr. Howard Schaffer examined the specimens removed histologically. He reported that the tissue from the nodule was hyalinized and contained many fibroblasts, some polynuclear and some irregular and pyknotic carcinomatous cells scattered throughout. The lymph node was reported as metastatic adenocarcinoma.

Gastric analysis ten days after operation showed Free acid 17-66, total acid, 51-120 in terms of N/10 NaOH in 100 cc of gastric contents. The blood sugar was 100 mg, urea 17 mg, and the blood Wassermann was negative. Blood count at this time was Hb 75 per cent, RBC 3,680,000, WBC 7,800. Urine normal.

Eighteen days after the acute perforation a partial gastrectomy was performed, after Moynihan's technic, through an upper left rectus incision. The pylorus and all palpable regional lymph nodes were removed. This operation included an anterior end-to-side gastrojejunostomy. The following day a direct transfusion of 400 cc of blood was given. The patient made an uneventful recovery and left the hospital on the twenty-first postoperative day. During the following 33 days he gained 15½ pounds in weight. Gastric analysis repeated at this time revealed Free acid 0, total acid 8-25.

*Pathologic Examination* by Dr. Baxter L. Crawford, showed an ulcerated area in the stomach, the floor of which was composed of fibrous tissue in which there was a marked inflammatory reaction. At the edge of the ulcer and in the floor, there was extensive infiltration by masses of epithelial cells. The infiltrating epithelial cells were of the columnar type, large and vacuolated, with a large amount of mucoid secretion throughout the tissue. The infiltrating epithelial cells involved all the coats of the stomach, but at the margin seemed fairly sharply defined. Beyond the area infiltrated by the epithelial cells there was an extensive inflammatory reaction, with fibrosis and mononuclear cell infiltration involving the submucous and muscular coats. This fibrosis caused a fusion between the submucosa and the muscular coats. The inflammatory reaction involved a much larger area than was involved by the carcinoma. The enlarged lymph nodes also contained small collections of infiltrating epithelial cells in which there was much mucoid secretion. *Diagnosis* Adenocarcinoma, (mucoid) perforating of the stomach, with metastases to the regional lymph nodes.

COMMENT—In 1896, Frederick A. Packard<sup>1</sup> reported a case of acute perforation of a gastric carcinoma in a patient who had had symptoms over a period of two years. In 1910, Anders and McFarland<sup>2</sup> reported a similar

case No operation was performed in either but the diagnoses were confirmed by autopsy

In 1904, Sir Cooper Perry and Lauriston E Shaw<sup>9</sup> recorded 20 perforations found at autopsy in 306 fatal cases of gastric cancer. In this report six instances of acute perforation are recognized. Death occurred from generalized peritonitis in five. A localized abscess was found in the other. No surgical intervention had been attempted. They found 17 cases without perforation who had died from generalized peritonitis.

Ian Aird,<sup>1</sup> in 1934, reported a case of acute perforation of a gastric ulcer that came to operation six hours after its occurrence. Closure was effected and recovery resulted. Enlarged nodes found at operation revealed adenocarcinoma on histologic examination. Because of these metastases no further operative procedure was attempted. He collected reports of six other cases which had undergone operation. Simple closure was effected in five, and closure with gastro-enterostomy in the other.

From a thorough investigation of the literature on this subject, Aird attempts to distinguish between primary carcinoma and ulcer with cancerous degeneration. He found that only 67 of the 79 reported cases were accompanied by clinical histories, which made classification possible. In 44 the perforations were acute and classified as fulminant. Twenty-four of these 44 cases underwent operation and 11 left the hospital alive. This is an operative mortality rate of 54 per cent. The diagnosis of malignancy was confirmed in approximately one-half of these cases. In the 24 cases operated upon, seven were treated by immediate gastrectomy. All of these survived operation. Aird concluded, from his study, that five of the 44 fulminant cases were definitely ulcer-cancer and six were definitely primary cancer which had ulcerated.

Delagiere,<sup>3</sup> in 1923, reported a case of acute perforation treated by closure and followed later by gastrectomy. His patient was well ten years afterwards. This, with the seven cases of successful immediate gastrectomy following acute perforation, is the only *other* successful one reported in the literature.

Determination of simple gastric ulcer previous to carcinomatous degeneration is attended with considerable difficulty. Findings that point toward such a condition are historic, clinical and pathologic. Important points in the history are duration and character of symptoms and weight loss. Clinical findings include those from operation and laboratory determinations of gastric contents. Of the pathologic findings, histologic examination is the determining one. Various criteria have been offered by pathologists in their attempts to determine the relationship between gastric ulcer and gastric carcinoma. Those given by Wilfred Newcomb<sup>7</sup> are valuable. He states, after exhaustive research, that there are four points in which a simple ulcer usually differs from carcinoma of the stomach. (1) Complete destruction of an area of muscle corresponding in size roughly to the floor of the ulcer. (2) The

presence of a large area of dense fibrous and granulation tissue in the floor of the lesion (3) The presence of endarteritis or thrombophlebitis in the surrounding vessels (4) Fusion or close approximation of the muscularis mucosa and muscularis at the margin of the ulcer The last named, he believes, is the only definite evidence of preexisting peptic ulcer not given occasionally by primary carcinoma Doctor Crawford believes that extensive inflammatory reaction and fibrosis in the submucous and muscular layers of the stomach wall beyond the area involved by the cancer seem to indicate a preexisting inflammatory reaction such as occurs in simple ulceration

The case presented herein gave a history of gastric symptoms for a period of 15 months before perforation His total weight loss was five pounds This loss occurred in a very brief period of time immediately preceding perforation The gastric analysis revealed definite hyperchlorhydria There was no anemia The perforation was of the fulminant variety in contradistinction to "silent" perforations usual in those from primary cancer Histologic examination gave evidence of definite fusion of the muscularis mucosa and the muscular layer of the stomach at the ulcer margin, also extensive inflammatory reaction and fibrosis in the submucous and muscular layers of the stomach wall beyond the area involved by the cancer From these findings a diagnosis has been made of peptic ulcer with secondary carcinomatous degeneration

Treatment is best considered as two distinct procedures The treatment of the perforation and treatment of the carcinoma The lowest mortality rate results from simple closure of the perforation in peptic ulcers There seems little reason for further immediate operative procedure even in the presence of malignant change If the stomach is resectable and if metastases have not involved the liver and the portal structures, secondary operation is definitely indicated Complete removal of the involved tissue with the pylorus and regional nodes and those in the lesser omentum and about the pancreas is indicated

Moynihan<sup>6</sup> states that if cancer develops in connection with a chronic gastric ulcer, recurrence is rare Finsterer<sup>4</sup> found that the prognosis of cancer in the presence of free hydrochloric acid is about one-half as good for five year survival as in cases of anacidity Hartman's<sup>10</sup> figures from the Mayo Clinic correspond with Finsterer's

#### REFERENCES

- <sup>1</sup> Aird, Ian Brit Jour of Surg, 22, 545-554, 1934-1935
- <sup>2</sup> Anders and McFarland Jour Proc Path Soc, Philadelphia, 3, 199, 1910
- <sup>3</sup> Delagiere Bull et Mem Soc de Clin, 49-136, 1923
- <sup>4</sup> Finsterer Rev de Clin, Paris, 53, 511-524, 1934
- <sup>5</sup> Lockwood Am Jour of Cancer, 26, 442, 1936
- <sup>6</sup> Moynihan Abdominal Operations, 4th ed, 1, 404, 1926
- <sup>7</sup> Newcomb, Wilfred Brit Jour Surg, 20, 279-308, 1932
- <sup>8</sup> Packard, Frederick Trans Path Soc, 17, 55, Philadelphia, 1896
- <sup>9</sup> Perry and Shaw Guys Hosp Report, 18, 147-149, 1904
- <sup>10</sup> Hartman, H R Col Papers Mayo Clinic and Mayo Foundation, 16, 27, 1924

## PILONIDAL SINUS IN A NEGRO \*

ELI SALEEBY, M D , AND P A McCARTHY, M D

PHILADELPHIA, PA

FROM DR P A McCARTHY'S SURGICAL SERVICE, PHILADELPHIA GENERAL HOSPITAL

WE ARE recording this case because pilonidal sinus and cysts are rarely found in the colored race. We believe it is an uncommon occurrence except among the Caucasian. This point is emphasized by most authors in the report of several hundreds of cases. Dr H B Stone of Baltimore, in 1924, was among the first to call our attention to the fact that there were no Negroes in his series of 61 cases. Dr G W Hoisley of Richmond, in 1933, made the same observation and in 1934 Dr Hubley B Owen stressed this point in reporting a series of 40 cases. Questioning several other active surgeons, we found that none had seen a pilonidal sinus in a Negro. In reviewing the literature, we found one case was reported by Hansler and Anderson in 1934. Breidenbach and Wilson reported four cases, in a series of 288, from Bellevue Hospital.

**Case Report**—A boy, J W, colored, single, age 18, was admitted July 5, 1935, to the Philadelphia General Hospital complaining of a burning "discharge from rectum." His antecedent history was quite irrelevant.

**Present Illness**—First noticed blood stains about three months ago, with constant moisture at the base of his spine. About one month ago a lump formed. He was examined proctoscopically and admitted to the hospital with a diagnosis of pilonidal cyst.

**Physical Examination**—There was a small draining sinus in the midline about one and one-half inches above the anal orifice. There was no tenderness, although the edges of the sinus were somewhat raw and bled easily. He had a good anal sphincter, and no mass or tenderness was noted inside the rectum.

**Operation**—Under general anesthesia methylene blue was injected into the sinus and the anal sphincter dilated. No dye was noted inside the rectum. The sinus which extended toward the coccyx was then excised. The structure of the tissue and the direction of the tracts were those commonly found in instances of pilonidal sinus. The wound was packed with iodoform gauze without sutures. The patient was discharged July 17.

**Pathologic Examination**—The specimen consisted of a mass covered with pigmented skin which presented a dimple leading into a blue stained sinus tract. On section the tract led into a space filled with granular debris, the subcutaneous fascia was firm and fibrosed. Microscopic section (R P Custer) showed a surface covered with negroid skin and appendages. The sinus tract led to a cystic space which was largely filled with chronic granulation tissue, and which contained hair in degenerated state. No actual hair follicles remained. The surrounding tissue was densely fibrotic and chronically inflamed. **Diagnosis**—Pilonidal cyst (Fig 1).

**COMMENT**—There is dispute as to the origin of pilonidal cysts and sinuses. Some authors think they are neurogenic and others ectodermic. The opinions seem to be equally divided, although the theory advanced by Harvey Stone that they are analogous to the preen glands in birds and amniotes, which develop at puberty, is gaining more adherents. Regardless what theory

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one accepts, we cannot escape asking ourselves this question Why do not pilonidal cysts occur in the pure colored race? We say pure because we have no assurance that there was not white man's blood flowing in the veins of the five reported cases Fansler and Anderson, judging by the color of their patient, believed she was one-eighth Caucasian

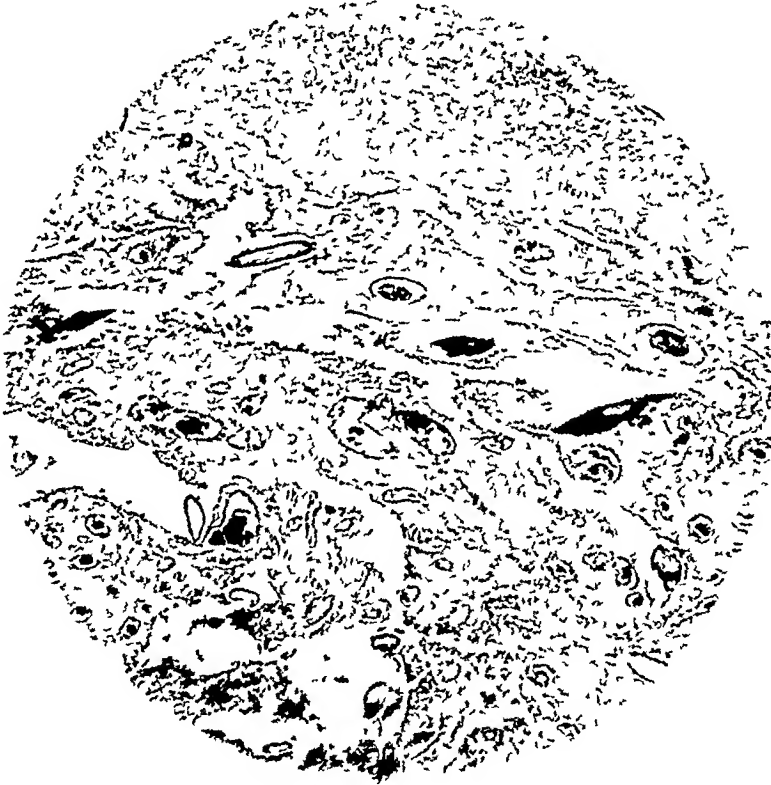


FIG. 1—Photomicrograph showing sinus tract with hair follicles and granular tissue

The only reasonable answers we think of is the negroid pigmentation It either inhibits the activities of the lining cells of the sinus, or neutralizes their products by chemical action This point is worthy of further consideration, and may lead us into virgin fields of investigation This condition should also be of great interest to the anthropologists, because it may lead to newer knowledge in the development of the human race

# MEMOIRS

REA SMITH

1876-1935

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CALIFORNIA and the Pacific Coast have lost a distinguished surgeon in the passing of Dr. Rea Smith, on November 29, 1935, his death was sudden,



REA SMITH M.D.

unexpected, and it brings to a dramatic close the successful career of one of our most important surgeons, esteemed citizens, and beloved friends

He was born in DeKalb, Ill., on November 16, 1876, to Addie A. Smith and Dr. Everett Russell Smith. His father, one of California's earlier and outstanding surgeons, was a man of learning and distinction, whose intellectuality seemed to find full expression in his son. Rea attended the Los Angeles High School and was graduated with honors in 1895; he entered Stanford University where he received his B. A. degree in 1899, in 1902 he received his degree of Medicine from the University of Pennsylvania. While attending Stanford University he received his "S," being a member of the Varsity football team. His fraternities were the Zeta Psi and Phi Alpha.

Early in his career he took an active interest in organized medicine and community problems, giving generously of time, energy and money. His mind was alert and inquisitive, his vision clear, his untiring energy and unusual ability qualified him for the high position he attained. In his greatness he was quiet, retiring, and free from petty jealousy, but if occasion demanded his leadership, he was direct and incisive, and accomplished that which was his goal.

Then came the call to the World War and he organized Base Hospital No. 3, with service on shore and with a Grand Fleet. Loaned to the Army with Evacuation Hospital No. 114, he shirked duty at no time, as was well demonstrated during the Argonne drive where, as always, he did more than his full share; he retired as Captain U. S. N., R. F.

For 32 years he was engaged in the practice of medicine. He possessed in full measure the qualities of a fine surgeon, and, having a definite inclination along this line, he devoted himself to this specialty. His judgment was good and his ability such that he rapidly rose to fame, being appointed from time to time to positions of honor. He served as Clinical Professor of Surgery in the University of Southern California, Past President of the Pacific Coast Surgical Society, Past President of the Los Angeles Medical Society, member of the American Surgical Association and of the American College of Surgeons, as well as belonging to state and local societies.

The esteem and affection by which he was regarded in the medical associations give only a slight idea of how highly he was thought of in general. His loss to our profession is felt profoundly; it is a deep sorrow to his multitude of friends. Genial, understanding, full of humor and human kindness, a noble, generous soul, exalted by boundless sympathy for his fellow men, he possessed an unswerving sentiment for principles of honor and right; he was devoted to his patients, associates, friends and family, who, in turn, loved him to a degree approaching adoration. Such was the personality of Dr. Rea Smith. Long will his memory live. He is survived by a wife and two sons, Everett R. Smith and Dr. Gordon K. Smith.

EDWARD C. MOORE

## CHARLES HARRISON FRAZIER

1870-1936

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DR CHARLES HARRISON FRAZIER was born in Philadelphia, April 19, 1870, educated in the Episcopal Academy and the University of Pennsyl-



CHARLES HARRISON FRAZIER, M D

vania, Class of 1889 He graduated from the Medical School of that university in 1892 Hospital internships under Dr J William White and Dr

John Ashurst at the University and Episcopal Hospitals completed his preliminary medical training. A year or more in Europe of postgraduate work in surgery, pathology and neurology under von Bergmann and Vichow rounded out his studies. On his return to Philadelphia in 1896 he was appointed to the clinical and teaching staff of the Medical School of the University of Pennsylvania.

It was an important period in the development of medical education in this country. The leaders of the profession had for some time realized that the standards of medical education in this country were inadequate and that the methods of instruction needed definite revision. Fresh from his European experience Doctor Frazier was heartily in accord with these changes. In 1901 he was appointed Dean of the University of Pennsylvania School of Medicine and Professor of Clinical Surgery. For the next ten years he labored to put the Medical School in the front rank of similar institutions in this country. It was a hard, thankless task, a battle against inertia, against the opposition of those long connected with the school who resented the suggestion that their ideas and methods were becoming outmoded. While many of his plans failed of immediate realization, he had the satisfaction later of seeing most of the more important fully fulfilled and the school directed along the pathways which his leadership and vision had indicated.

While Dean of the Medical School he had time to carry on an increasingly heavy surgical practice, to establish and edit the University of Pennsylvania Medical Magazine, to establish one of the first laboratories of surgical pathology organized in this country, to lay the foundations for a department of research surgery, and, with Spiller, to carry on the experimental work on the treatment of trigeminal neuralgia which later made the surgical relief of this condition a safe procedure.

In 1898, Doctor Frazier was elected a member of the Philadelphia Academy of Surgery. His first presentation before it was made in 1902, when he described a retractor to elevate the brain. In 1908, he gave the Annual Oration. In 1912, he was elected vice president, and in 1916, president. His two chief surgical interests were the surgery of the central nervous system and of goiter. While most of the papers presented before this Academy concerned the thyroid, two important communications, one on the transfrontal approach to the hypophysis, and the second on suture of the recurrent laryngeal nerve, touched on his original and ingenious development of neurosurgical technique.

During the War, he was neurosurgical consultant to the Surgeon General. He had charge of the Neurosurgical Service at Base Hospital No. 11, at Cape May and No. 41, at Fox Hills, Staten Island. He represented the Surgeon General at the Interallied Surgical Conference in Paris, in 1920, presenting a paper on the "Results of the Treatment of Injuries to the Peripheral Nerves."

In 1922, Doctor Frazier was appointed John Rhea Barton Professor of Surgery in the University of Pennsylvania Medical School. His ability as

an organizer was at once apparent. The Surgical Service was adapted to the needs of the student and steps taken to use the teaching material to the best possible advantage. A proper relationship was established between the clinical and research departments and every effort made to demonstrate not only the routine surgical procedures but to stress the physiologic, pathologic and physiochemical facts upon which such maneuvers are based.

Many honors came to Doctor Frazier. He was a Fellow of the College of Surgeons, a founder and president (1925-1927) of the Society of Clinical Surgeons, a founder and president (1922-1923) of the Society of Neurologic Surgeons, president of the American Neurologic Association (1928-1929), a member of the American Surgical Society, of the American Society for the Study of Goiter, an honorary member of the Deutsche Akademie der Naturforscher, and of the British Neurosurgical Society. He received the degree of Doctor of Science from the University in 1925 and was elected one of its Trustees in 1934.

Anyone who knew Doctor Frazier was bound to him by affectionate respect and esteem, and even though his frankness of speech might sometimes hurt, one could not long resist his charm. What he demanded above everything else of all people was honesty, honesty of mind and the willingness to work with honest purpose. Where he found these qualities he gave himself without reserve and his support was whole hearted.

He died at North Haven, Maine, July 26, 1936. During the last ten months of his life he suffered pain continuously and knew the nature of his illness. In spite of this he continued an active interest in the affairs of the Surgical Department, making suggestions and plans for the future, uncomplaining and patient under his affliction. His last months were an epitome of his life. Under opposition and against odds, he fought gallantly never losing his self-control and refusing to admit defeat.

FRANCIS C. GRANT

#### EDITORIAL ADDRESS

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## TRANSACTIONS OF THE SOUTHERN SURGICAL ASSOCIATION

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December 15, 1936

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### PRESIDENTIAL ADDRESS

#### WIDER HORIZONS FOR THE SURGEON

HARVEY B STONE, M D

BALTIMORE, MD

THE generation of American surgeons who were approaching the zenith of their careers when I was a young man getting my training comprised among its leaders many men of a type that has few exemplars among my own contemporaries. Some of these men have left us. Fortunately, many of them are spared to us, still actively at work or filling the important rôle of elder statesmen to our beloved guild of surgeons. They were and are something more than masters of their specialty in the healing art. They possessed a vigor of energy, a gift of expression, an inspirational force as teachers that were characteristic. Furthermore, they were endowed with that quality of magnetism, of personal charm, and dramatic sense that made many of them public figures of renown—what the current phrase describes as “colorful personalities.” Among them are such names as Murphy, Ochsner, Joseph Blake, Brewer, Deaver, Matas, the Mayos, Cline and our own Doctor Finney and many more. The mere reading of the list has the bugle-call effect of the names of victories on regimental banners. But when I look for men who may be regarded as successors of the same type and qualities, their scarcity is most striking, and, as a member of a lesser generation, I am inclined to hide my diminished head in humility, if not in shame. Yet, I fully share the optimistic views of the future of surgery that were so forcefully presented to us two years ago in Dr. Frank Boland’s presidential address before this Society.

Perhaps this hopefulness, despite our lesser stature than the Great Generation, is not so inconsistent as it seems, for we are told that each generation stands on the shoulders of its predecessors and that an ordinary man standing on the shoulders of a giant can see farther than the giant can. The exploration of this ever widening horizon is the purpose of my paper.

Since the beginning of this century, science in many fields has made revolutionary advances. Physics has broken the "indestructible" elements of our student days into electrons, protons and neutrons. Astronomy has extended the universe beyond the comprehension of the ordinary layman. Organic chemistry has recognized, refined and synthesized a multitude of new products. The geneticists have traced farther and farther the factors that influence heredity. Biology has learned much of the properties of growth and repair of living tissues. Endocrinology and the study of nutrition have opened wide new fields. In many other branches of science, too numerous to mention, great strides forward have been made. What has all this to do with surgery?

Is not surgery an art in which the deft and bold hand works its masterpieces of skill for the benefit of suffering humanity? It is, indeed. Is not surgery a scholarly discipline in which the learning and experience of the past are critically analyzed, correlated and catalogued? It is, without doubt. Is not surgery a high calling—almost a priesthood—in which character, integrity, humanity and devotion to high ideals are the very basis and cornerstone of the structure? It is, most emphatically. Surgery is by universal acclaim all of these things and it is more. It is a vital and integral part of the rapidly growing field of science—the development of man's manifold activities that, perhaps, chiefly characterizes the last three centuries of his history.

The chemist and the physicist, who explore the intimate structure of the atom, work on the simplest known forms of matter to restrict the difficulties of their problems. When they come and report to us their findings about helium and hydrogen, let us not forget that general laws of atomic structure apply also to the atoms that make up the material of the human body. The men who seek to understand the laws governing solutions and gels, colloids and semipermeable membranes, in the comparatively uncomplicated experiments of the laboratory, are working on problems that directly concern the behavior and mechanism of living beings. The students of radiant energy in its various forms are engaged with a subject that touches medicine at innumerable points. If this be true of the so called basic sciences of the nonliving world, what of the many phases of biologic investigations? Much more obviously, the thoughts, the experiments, the discoveries and the conclusions of the biologists are of the greatest importance to those of us who work in the field of medicine—which is, after all, nothing but a specialized field of biology. And let us not forget for a moment that great field of biology that spreads over into philosophy, religion, ethics and psychology—the biology of the mind. If any of us need reminders of the bearing of the mind on health and physical welfare, we have Christian Science as a monumental object lesson.

Lest any one object that I am straying far afield from the proper domain



of the surgeon, let me relate to you certain gleanings from casual reading in various scientific fields during the past year and the chain of ideas that they set going. In a most stimulating address before the Zoologic Section of the American Association for the Advancement of Science, Dr. Oscar Riddle spoke on certain phases of evolution. The part of his address that is pertinent here may be condensed as follows. It is known that large numbers of inorganic compounds which probably could not exist during very early phases of earth's history did come into existence in epochs preceding the appearance of living things. It has also been proved that formaldehyde, sugars and other organic chemical substances, some of them containing nitrogen, are generated under conditions which must have prevailed on the earth's surface before, during and after the origin of living things. The agents to the building up of such organic matter are none other than sunlight, ordinary temperature, colored surfaces, water and carbon dioxide. There exists scarcely a doubt that during long periods of the earth's history, preceding the appearance of living matter, many localized areas of its surface provided suitable conditions for the synthesis of sugar and some amino acids.

There is now a new word to add to this discussion of the approach of nonliving toward living substance. For some years it has been fairly evident that the substances or units known as viruses are smaller than any visible cell or organism and that they nevertheless, show the one property which is most characteristic of life—that of self-reproduction. They have seemed part of a bridge between those smaller but lifeless organic molecules which, as we have just noted, form spontaneously on the earth's surface, and those larger molecular aggregates which are bacteria and cells endowed with all the properties of life. The virus appears to stand nearer to life than to the spontaneously formed sugars and amino acids. Within recent months Stanley has prepared a crystalline protein which is apparently the virus of the disease of tobacco known as "mosaic." These crystals, of definite chemical and physical properties, unchanged after ten successive recrystallizations, have the remarkable power of indefinitely building themselves anew when brought into contact with suitable living tissue—the tobacco plant—exhibiting thus one of the characteristics of living matter. Now, when the known properties of this virus—its molecular size and its power to reproduce itself and many other qualities—are compared with those of the gene, there is a striking parallel. The genes, be it remembered, are those component units of the chromosomes of living cells to which biologists have attributed many important functions of living matter, notably the carrying of hereditary traits from one generation to another, and the peculiar characteristics of each species. So much for a very inadequate extract from Doctor Riddle's most thought-provoking article.

Recently Rous and his associates of the Rockefeller Institute have published a series of experiments on rabbits with a virus disease. In certain strains of wild cotton-tail rabbits there occurs an endemic infectious form of skin papilloma which is transmissible by a filterable virus. When this virus is transmitted under proper conditions to laboratory rabbits, it reproduces the

papillomatous tumors, and, in a certain number of instances, these ordinarily benign tumors take on definitely malignant changes and become cancers. Doctor Rous and his associates are properly conservative in the conclusions they draw from these experiments, but it seems well proved that the introduction of this agent, the filterable virus, is the primary cause of the development of the cancers.

To summarize Riddle gives us a long look backward over the earth's history, beginning with simple chemicals and the energy of sunlight and leading up to complicated chemical substances. Stanley tells us of a filterable virus which is a nonliving, crystalline substance but which in structure and behavior suggestively resembles those components of living cells—the genes—that play a large part in inheritance and reproduction of life. Rous establishes a relationship between a virus and a form of malignant disease. At this point I would remind you that a presidential address in this Society is not by custom limited to restrained scientific caution. I am now about to avail myself of this latitude by sailing off “into the blue” of pure imaginative speculation with no excuse except the privilege of doing so and the inviting take-off provided by the serious work referred to above.

Admittedly, the great problem of medicine today is the cancer problem. We know a great deal about cancer but are ignorant of far more. We can do something toward its cure and something more toward its alleviation and restraint, but so pitifully little compared to what we would like to do. It is an object of endless thought, study and experimentation over the whole medical world. Perhaps, even if we knew its cause in all its possible complexity, we should still be unable to solve the problem of its successful treatment, but surely until we do understand its nature better, our attempts at treatment are essentially blind—and unsatisfactory. There have been so many theories advanced to explain the development of malignant disease that another guess can do no particular harm except to expose its author to devastating criticism, and since presidential addresses are not subject to discussion, my chastisement will at least not be immediate and public. To make my offense as brief as possible, it shall be reduced to skeleton outlines.

The most acceptable view of malignant disease at present regards the cancer cell as a new species of cell, essentially a new animal, derived from a presumably normal cell by some form of mutation. This mutation once established, the cancer goes along leading its own life, independent largely of restraint by the host from which it sprang and from which it derives food, shelter, warmth and protection, but to which it returns no service, not even physiologic obedience. It is reasonable to suppose that this change occurs because of some alteration in the laws of inheritance which normally provide that daughter cells shall develop along established lines, subject to the physiologic restraints that affect the mother cell. The mechanism of inheritance appears to be bound up intimately with the genes. Any agency, external or internal, that violently altered the internal structure of the cell, would undoubtedly kill it. But an agency that modified the cell in a less extreme

manner might conceivably result in a cell that could still live but was so changed that it no longer was a legitimate descendant of its parents. Such an agency might conceivably be a chemical body so similar to the genes themselves that it might supplant a gene during the process of cell division, or be incorporated as an extra gene, or combine with a gene to form an abnormal gene. If a filterable virus, with the properties that have been attributed to them, were available at opportune moments during cell activities, especially division, it is not an unimaginable fancy that some such action might take place. Again, if radiant energy in some form, with its known power to alter molecular arrangements, were to disturb, slightly, the chemical composition of the large molecules in the cell nucleus, a similar effect might result. Or if chemical substances like those in certain coal-tar derivatives, of known resemblance to the hormones of the body, were to enter into combination with the substance of the cell so as to alter or damage the mechanism of inheritance, a series of abnormal daughter cells might be inaugurated. Now, it is known that all three of these particular agencies may actually produce such results, and perhaps many other agencies as yet less clearly recognized may have similar effects. This speculation as to the manner of action of these agencies is not, perhaps, of practical value at present, perhaps not even very new or original, but it may at least have the merit of crudely visualizing a process that interests all of us intensely and of stringing together some of the known facts, even though the thread on which they are strung is very tenuous.

I seem to have gotten rather far from my subject in this excursion into the realms of fancy, yet this diversion may serve as an illustration of what I am trying to express. If the men who are working with viruses of plant diseases have made important advances, we should know about it, not merely as a matter of general cultural or scientific interest but because it may throw light upon some surgical problem. When the metallurgists produce new alloys or the students of plastic materials evolve substances with new properties, these things may be especially adapted to some surgical purpose as instruments or braces. When the cellulose chemists develop new threads or fabrics, they may be useful for dressings or sutures. Do any of you feel that we yet have the ideal suture material? The students of electricity, in its manifold forms, have indirectly contributed enormously to diagnosis and therapy in all fields of medicine, and there is no reason to believe that they have exhausted the possibilities, but we must be alert to recognize and utilize the aid they make available. To extend similar comments to the many diversified fields of all the sciences is unnecessary. But it should not be supposed that science alone is of concern to us. Today as never before we are affected by matters economic, social and political, and surgery, like every other human activity, does not escape these influences, which are real and practical in everyday experience.

But you say I am asking impossibilities. Surgery itself is a demanding mistress, taking all the energy, the time, the thought that any man can give. How then expect the surgeon to keep abreast of modern physics—a subject so

abstain that the average man is helpless at the thought of it, and chemistry with its multitudinous subdivisions, each actively and vigorously developing what can we hope to do with that? Even our near relative, biology, is so vast that our part of it seems a little corner. The answer is, of course, that no one of us can even remotely approximate the knowledge that we should like to have and that would be so helpful to us. The day of the universal scholar, who took all learning for his province, is long since past. But what no one man can do, many men acting together may accomplish. Fortunately, we are united in an organization to combat the forces of ill health and are each component cells in a highly developed whole, not isolated amebae leading solitary lives. However, if the organization is to function properly, each unit must perform his own full duty and one of those duties is to stretch his mental horizon beyond the narrow scope of his daily task. Let the man who has a mechanical bent learn from the engineers and mechanics how to devise more useful tools for the needs of surgery. Let the man with a physiologic trend help us to improve the preoperative and postoperative care of our patients. Let him with chemical leanings give us better antiseptics and anesthetics. We need to know what the bacteriologists have to tell us about immunity and serums and vaccines. We need so many things that each can help. And most of all, we need the large view, the wide horizon, not only facts and knowledge gathered from many fields, but the sense of proportion, of balance, of sanity, that comes from seeing life, surgery and ourselves in true relations and proper setting. And lastly we must have a forum for the exchange of our gleanings from far and near. The various organizations of the profession provide such forums, and we are gathered tonight in one such meeting place, that I hold to be second to none in its many useful and charming qualities. If we would make it still better, richer for each of us both in practical matters and in the growth of our souls, let us send our minds to wander the far horizons and bring back here the fruits of our wanderings. It is said that in the heyday of Venice, each of her many vessels that sailed all the known seas had to bring back some treasure for the enrichment of St Mark's Cathedral. St Mark's, in consequence, remains today one of the world's wonders. The Southern Surgical Society may well become the St Mark's of the surgical world.

# SURGICAL TREATMENT OF FACIAL SPASM

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PAROXYSMAL disturbances of function are characteristic expressions of the surgical diseases which involve the cranial nerves. The well known paroxysms of pain of *tic douloureux* of the trigeminal and glossopharyngeal nerves and the paroxysmal vertigo of the Ménière's syndrome strikingly illustrate the tendency of these nerves to manifest disturbance in an explosive manner. The facial and spinal accessory nerves likewise may be involved in paroxysmal affections which, by exaggeration of motor function, produce both deformity and disability.

Surgery of the facial nerve may be required to restore its function when the nerve is paralyzed and to reduce or abolish its function when spasm of the muscles it supplies causes a disabling facial deformity. Facial spasm may be unilateral or bilateral and either clonic or tonic in type. In severe cases it not only causes an embarrassing deformity but because of interference with vision in bilateral cases it may result in serious disability.

The pathology of facial spasm is entirely speculative. Wilfred Harris<sup>1</sup> believes that clonic unilateral facial spasm is due to a degenerative lesion of the nerve at or below the geniculate ganglion. In support of this opinion he cites the occurrence of spasm following recovery from facial paralysis due to injury of the nerve trunk. Harris rejects Gibson's<sup>2</sup> theory that facial spasm results from pathology similar to that of spasmodic torticollis on the grounds that in the former condition only one nerve (the facial) is involved, while in the latter disorder the cervical nerves as well as the spinal accessory are implicated. In further support of the neural basis of clonic unilateral facial spasm may be mentioned the tendency of the affected facial muscles in long standing cases to develop weakness and contractures. Bilateral facial spasm is most probably of cerebral origin and may result from encephalitis. This appeared to be the cause in one of the patients under consideration in this paper.

Parker<sup>3</sup> reports two cases of bilateral facial spasm (*paraspasme Sicard*). Both cases were believed to be due to cerebral disease. One had definite Parkinson's disease and the other had an early Parkinson's syndrome following encephalitis. There is evidence to support the opinion that the pathology of bilateral spasm differs from that of the unilateral type. The muscle contraction of the former is tonic in character while the latter is clonic. Moreover, in bilateral spasm there is often spasm of other groups of muscles affecting phonation and deglutition. Evidence is lacking to support the view that either the bilateral or unilateral spasm is due to a lesion of the cortical centers controlling facial movements.

Spontaneous recovery from well developed facial spasm probably never occurs. Starting usually as blepharospasm, the contractions spread until they involve the musculature of one or both sides of the face and extend into one or both platysma muscles. Bodily movements, excitement or fatigue increase the spasm while quiet and tranquillity give some relief. The contraction of the facial muscles, particularly those about the eye and angle of the mouth, produces a conspicuous deformity.

The victims of the severe types of bilateral facial spasm (paraspasme Sicard) are often completely disabled. They are unable to walk safely in traffic, unable to read, and sometimes because of closure of the eyelids and contraction of the muscles about the mouth it is with great difficulty that they can feed themselves. The expression of the face in the severe types of bilateral spasm is similar to that registered after tasting some acid, pungent substance.

During the past year we have had under observation five patients with facial spasm. There were three patients with clonic unilateral spasm and two in whom the spasm was bilateral and predominantly of the tonic type. The patients with unilateral spasm sought relief chiefly because of the embarrassment resulting from contraction of the facial muscles, particularly those about the eye. Reading was difficult and the patients were continuously disturbed by the facial grimaces. Many kinds of therapy had been tried without relief. The contractions persisted with varia-

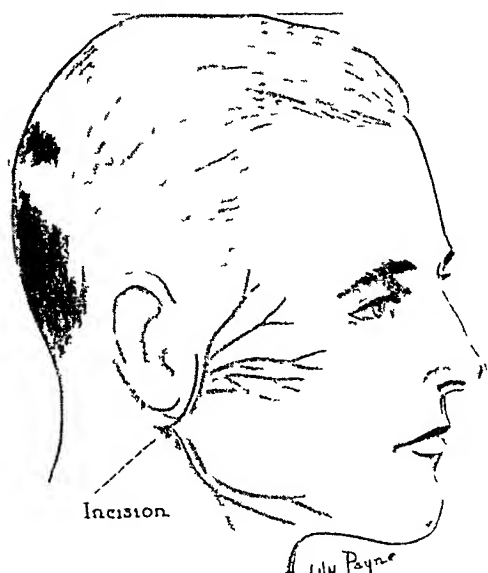


FIG 1.—Incision for exposure of the trunk and main branches of the facial nerve the trunk and main branches being shown diagrammatically. Through this incision which is made under local anesthesia the trunk can be followed posteriorly to give exposure to the mandibular branch and main trunk of the nerve.

tions but with increasing intensity and annoyance.

Two of the patients had severe disabling bilateral tonic contractions of the entire facial musculature. The first of these patients was a man, age 27, who probably had encephalitis as a result of chronic manganese poisoning. The deformity in this case was very striking. The whole face was involved in almost continuous tonic contraction which closed the eyes tightly and retracted the angles of the mouth. The voice was impaired and difficulty in talking was intensified as the facial contractions became more severe. The tonic contractions appeared in rapid succession, giving an almost continuous picture of a deformity in motion. The patient was completely disabled and had to be led around.

The second case of bilateral spasm was in a frail man, age 74. In this case there was no history of encephalitis and no evidence of arteriosclerosis in excess of that which might be expected in a man of his age. The spasms

## FACIAL SPASM

in this patient had started around the left eye two years before and gradually spread until they involved the entire distribution of both facial nerves. The contractions of the platysma muscles forcibly depressed the chin while the tonic spasm of the orbicularis oculi closed the eyelids tightly. The whole face was in almost continuous spasm, producing hideous grimaces which followed each other in rapid succession. Medical treatment and psychotherapy are of no benefit to facial spasm.

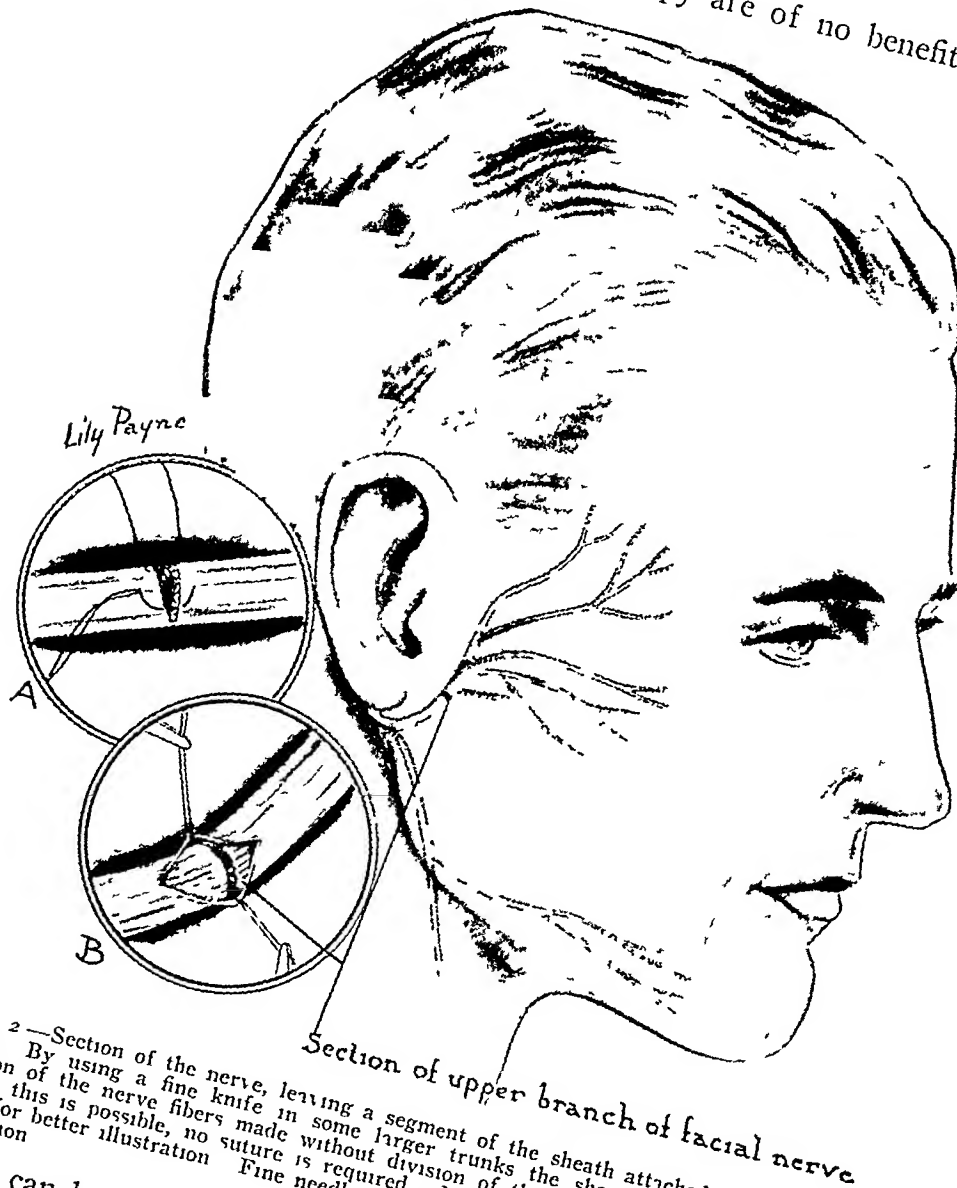


FIG 2—Section of the nerve, leaving a segment of the sheath attached as shown in insert A. By using a fine knife in some larger trunks the sheath may be separated and section of the nerve fibers made without division of the sheath, as shown in insert B. When this is possible, no suture is required. Magnification of the nerve in inserts A and B for better illustration. Fine needles and silk sutures are necessary for accurate approximation.

The condition can be relieved only by paralysis of the nerve by section, or by injection of the nerve with alcohol. With recovery from the paralysis the spasm usually returns but the patient is grateful for a period of relief which may last from six to twelve months. The nerve trunk may be injected with alcohol where it leaves the styloid foramen but this procedure is not so simple as it might appear. Injection of the facial trunk produces paralysis of the entire distribution.

of the nerve Individual branches of the nerve may be injected just at the point where they cross over the ramus of the jaw but the landmarks here are not especially reliable due to the considerable variation in the arrangement of the nerve branches There is some objection to injection of alcohol in the branches of the nerve inasmuch as alcohol may cause scarring of the nerve and interfere with recovery of muscle function, provided some form of anastomosis is later required

In unilateral clonic spasm in which the greatest contraction is in the orbicularis oculi muscle group, we have divided the nerve through a short incision, under local anesthesia (Figs 1 and 2) We have preserved the



FIG 3—Male age 43 with clonic spasm of the right side of the face for one year with most annoying contraction in the orbicularis palpebrum The lower branches of the nerve were involved to a lesser extent Section of the branches to the orbicularis frontalis and muscles of the upper lip under local anesthesia on December 9, 1936 Photograph shows patient in slight spasm of the right side of the face At times the eye was forcibly closed by the spasm There was beginning contracture of the muscles of the affected side



FIG 4—Photograph of patient shown in Fig 3 on the day following section of the branches of the nerve to the orbicularis frontalis and muscles of the upper lip The annoying spasm is completely relieved

mandibular branch of the nerve after section and immediate suture of the upper trunk which supplies the branches to the brow, orbicularis and upper lip Preservation of the lower branch keeps the mouth balanced and prevents the unilateral smile which is so disfiguring (Figs 3 and 4) The slight spasm which may persist in the depressor muscles of the mouth and the platysma is not troublesome and appears to diminish after the more severe contractions of the upper face have been relieved

We prefer section with immediate suture of the nerve to produce paralysis rather than the injection of alcohol It is important to save the mandibular



branch, if not too much involved, to minimize the deformity, and this can be accomplished more precisely by section of the nerve than by alcohol injection (Fig 5)

The deformity resulting from paralysis of the two upper branches of the nerve for the relief of facial spasm is not so marked as that following division of a healthy nerve. The facial muscles in long standing spasm acquire contractures so that they do not show the relaxation and flabbiness so common in Bell's palsy. The deformity of facial paralysis varies con-



FIG 5 —Photograph of patient four months following section and immediate suture of the branches of the nerve to the upper lip eyelids and brow on the left side. The deformity is not marked although it is evident in the wider palpebral cleft on the left. The mouth is well balanced. Operation July 3, 1936

siderably in different individuals. In older patients the flabbiness of the tissues accentuates the deformity caused by the paralysis.

In one of the patients in our series, who had severe bilateral spasm, the branches to the eye and upper lip were divided on one side with preservation of the mandibular branch. On the other side the trunk of the nerve was injected with alcohol. Although some spasm persisted in the mandibular branch it was thought best to preserve it to enable the patient to drink fluids (Figs 6, 7, 8, 9 and 10).

Prior to the operation this patient was tested with bilateral injection of novocain into the nerve trunks to determine his ability to drink after both

FIG 8



FIG 6



FIG 7

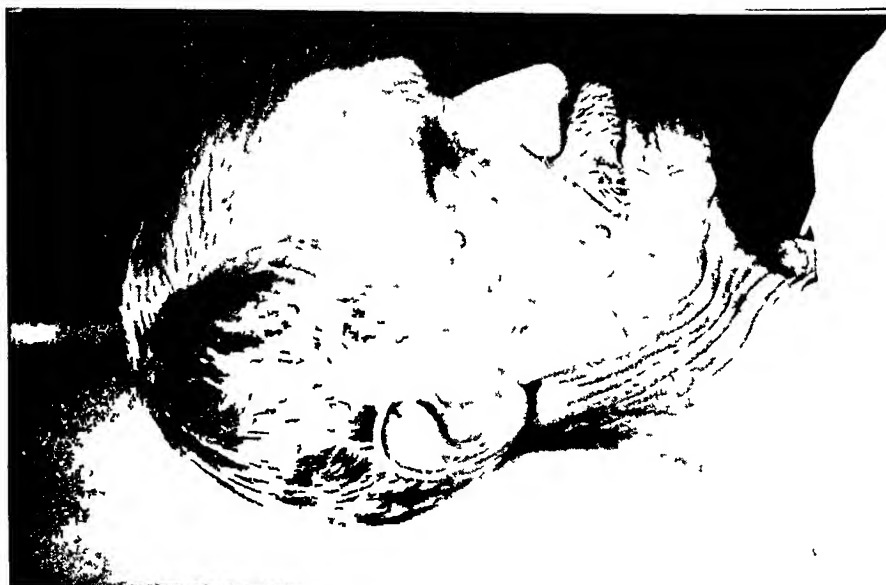


FIG 6—Male, age 74, with severe bilateral facial spasm involving the entire dorsum of both nerves. The muscles of the face were in almost continuous spasm with associated contraction of the platysma muscles. Contraction of these muscles depressed the chin, the upper lip was retracted and the eyes tightly closed during the spasm. The patient was unable to read and his walking was interfered with. Operation July 24, 1936. Temporary bilateral paralysis was produced by injection of 2 per cent novocain solution into the nerve trunk. It was found the patient had great difficulty in drinking. The nerve trunk on the left was injected with alcohol and a few days later the branches to the upper lip, eyelids and brow were divided under local anesthesia.

FIG 7—Photograph showing blepharospasm of the right side and contraction of the platysma.

FIG 8—Photograph showing left side of face with spasm of the orbicularis and platysma. None of the photographs was taken during a severe spasm.

nerves were paralyzed. This was the older of the two patients with bilateral facial spasm, a man 74 years of age. It was found, after the injection of novocain, that he had great difficulty in taking fluids. He may have acquired some expertness in this respect but he was a rather frail, undernourished man, and it was not thought wise to interfere too much with his ability to eat and drink. By preserving the mandibular branch he was inconvenienced very little in eating and drinking (Figs 6, 7, 8, 9 and 10).

This patient was entirely relieved of the spasm for about six and one-half months following alcohol injection of the trunk on the left and section of the upper branch with immediate suture on the right. His general condition im-

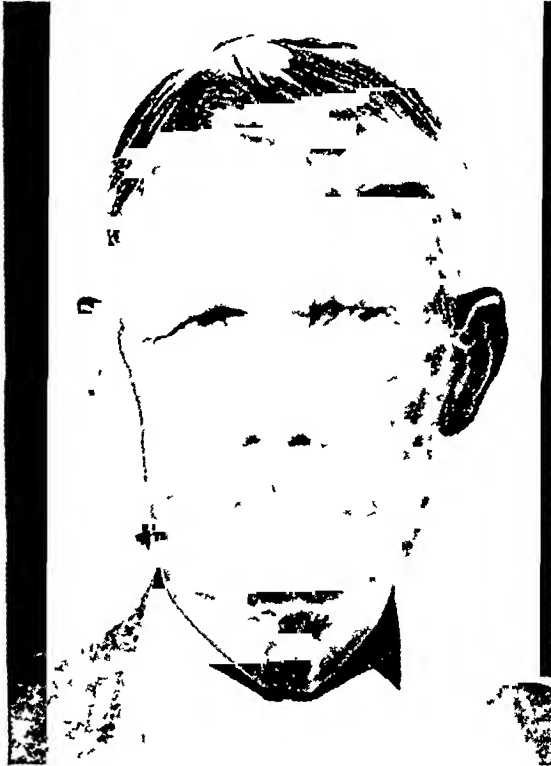


FIG 9—Photograph of patient five days after bilateral facial paralysis following injection of the nerve on the left with alcohol and section and immediate suture of the branches to the brow, eyelids and upper lip on the right. The slight spasm in the mandibular branch is shown on the right side. This branch was preserved so that the patient might have less difficulty in eating and drinking.

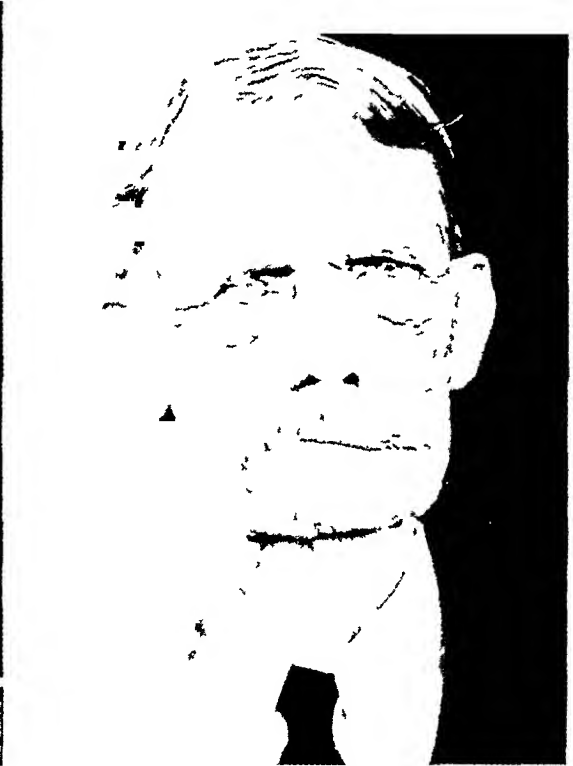


FIG 10—Same patient as shown in Figs 6, 7, 8 and 9, three months after the production of bilateral facial paralysis with the exception of the platysma and the muscles of the right lower lip. There is evidence of slight spasm persisting in these muscles but this did not inconvenience the patient. No return of function in the paralyzed muscles. There is slight sagging of the lower lid on the right. Faciohypoglossal anastomosis as a primary procedure would restore function to the paralyzed muscles before atrophy had become advanced and is especially indicated in older patients.

proved greatly during the period of relief of the spasm. In February, 1937, the spasm returned and gradually became as severe as it was before the bilateral paralysis was produced in July, 1936. The paralysis following section and suture of the nerve on the right side lasted longer than that of the left facial nerve which was injected with alcohol. The spasm of the orbicularis oculi on the left was more disabling to the patient because the right eye had been practically blind for forty years, due to corneal ulceration.

The patient was readmitted on April 9, 1937. Operation April 10, 1937.

Under local anesthesia a faciohypoglossal anastomosis was effected on the left side. The cervical sympathetic chain was divided just below the superior ganglion and immediately resutured. Three days after operation the patient was making a good recovery.

In the second patient with bilateral facial spasm, operated upon by my associate, Dr. W. G. Clutchfield, one side was injected with alcohol after exposure of the nerve. About two months later the nerve trunk on the opposite side was sectioned and immediately sutured. This patient did not experience much trouble in taking fluids, and, as is always the case, he did not have as much facial deformity from bilateral paralysis as is present when



FIG. 11.—Photograph of child, age nine, with congenital bilateral facial paralysis. There is practically no facial deformity but characteristic absence of facial expression is noted.

paralysis is of the unilateral type (Fig. 11). When examined about 12 months following section of the nerve, there was evidence of some return of the spasm but the patient was not sufficiently annoyed by it to desire anastomosis.

Section with immediate suture of the nerve for facial spasm is somewhat analogous to alcohol injection of the trigeminal nerve for the temporary relief of tic douloureux. Recurrence of the disorder is almost inevitable in both conditions upon regeneration of the nerves. Permanent relief of facial spasm can be obtained only through changing the source of the innervation to the involved muscles by anastomosis of the facial with another motor cranial nerve.

For this anastomosis we have always preferred the hypoglossal (Figs 12 A, B, and C) because of its functional similarity to the facial.<sup>4</sup> The results of faciohypoglossal anastomosis are very satisfactory in so far as recovery of motion on the affected side is concerned. There is evidence of improved tone in the face after about three months following anastomosis, and in about three and one-half months the first feeble contractions are seen about the angle of the mouth. Recovery of the muscle groups takes place from below upward with the function of the orbicularis returning last. We have never seen a case of faciohypoglossal anastomosis in which the frontalis muscle resumed function. Although faciohypoglossal fusion is uniformly successful in restoring motion to the paralyzed muscles, it does not restore emotional expression. A fair imitation of emotional expression may be acquired by reeducation but it lacks spontaneity and genuineness.

Kennedy,<sup>5</sup> in 1899, reported a case of facial spasm treated by facio-accessory anastomosis. Gibson,<sup>2</sup> in 1921, used the hypoglossal for the same condition. Wilfred Harris recommends faciohypoglossal fusion for the relief of facial spasm and Adson prefers the spinal accessory which he has used in two unreported cases. To narrow the lid cleft following section of the nerve, Letriche,<sup>6</sup> Sicard, Robineau and Haguénau,<sup>7</sup> and Adson<sup>8</sup> recommend simultaneous section of the homolateral cervical sympathetic chain. This produces a recession of the eye, a slight droop of the upper lid and lessens the lacrimal secretion which is sometimes annoying when the lower lid is paralyzed.

In severe cases faciohypoglossal anastomosis should be employed as a primary procedure to effect a permanent cure of the spasm. If the condition is bilateral, the hypoglossal should be used on one side and the spinal accessory on the other. However, in some cases, sudden complete bilateral facial paralysis interferes with eating and drinking. To determine the amount of interference with these functions, brief paralysis of the entire face should be produced by injecting both facial trunks with 2 per cent novocain solution and then testing the patient for eating and drinking. If much difficulty is experienced by the patient, the operation should be performed in two stages, the second following about six months after the first.

Nerve anastomosis was recommended in two cases of the group under consideration. In one it was recommended after return of spasm following

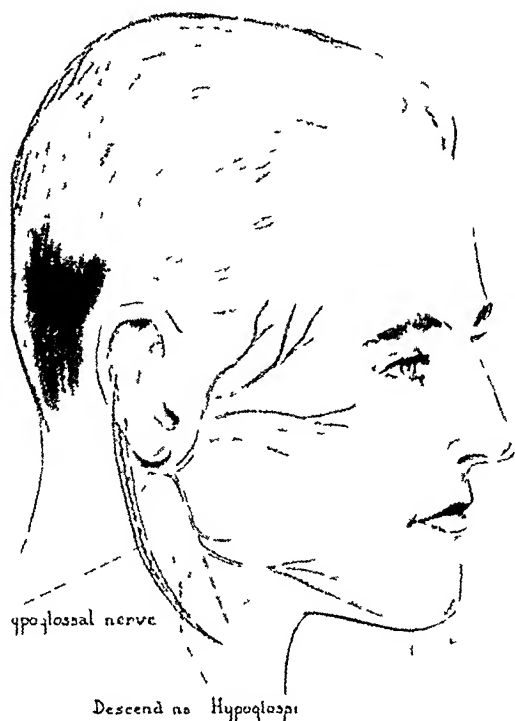


FIG 12A—Faciohypoglossal fusion. Position of incision for exposure of the facial and hypoglossal nerves. Incision begins just over the mastoid and curves downward and forward following, when possible, a skin crease.

section of the nerve and in another it was suggested as a primary procedure. All of the patients insisted on a preliminary section or an injection of the nerve with alcohol. The psychology of the situation is such that, after full explanation, I am willing to leave the choice of the procedure to the patient.

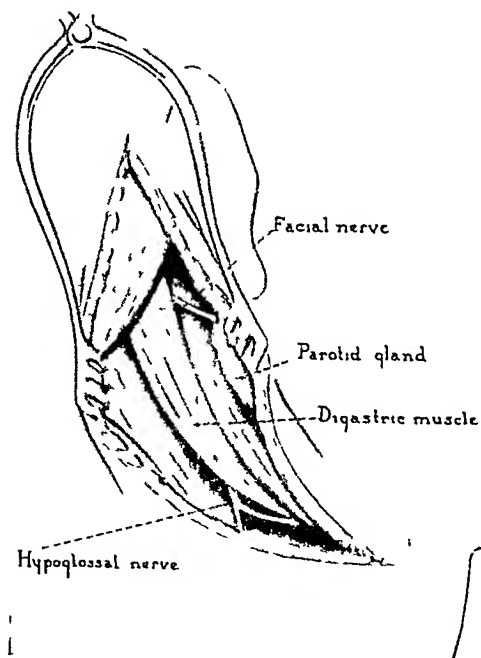


FIG. 12B—Faciohypoglossal fusion. The sternomastoid muscle is retracted backward. When the mastoid tip is long it is sometimes removed with a chisel for better exposure of the digastric fossa. The hypoglossal is located just posterior to the corne of the hyoid bone and traced backward but not divided until after the facial has been exposed and sectioned as near as possible to its exit from the facial canal. The best guide to the trunk of the facial is its small branch to the posterior belly of the digastric muscle. The facial trunk is seen as it leaves the digastric fossa. At the lower angle of the incision the descendens hypoglossi and main trunk of the hypoglossal are shown.

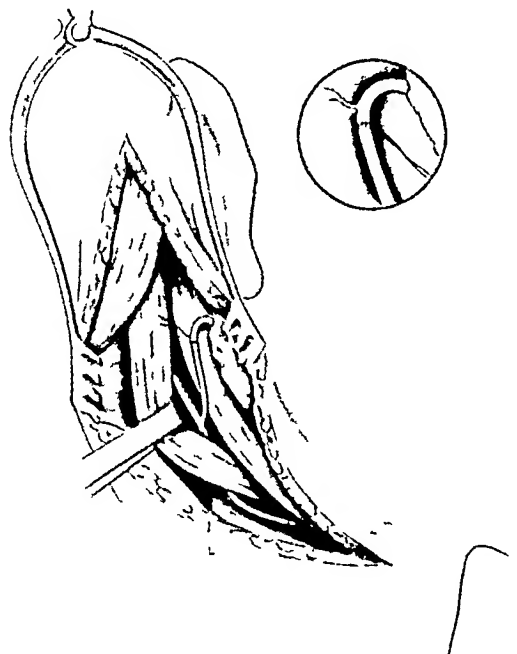


FIG. 12C—Faciohypoglossal fusion. Anastomosis of the proximal end of the hypoglossal with the distal end of the facial is shown. Three or four silk sutures are sufficient to make accurate approximation of the two nerves. The drawing shows suture of the descendens hypoglossi to the distal segment of the hypoglossal. This is done to prevent atrophy of the tongue on the operated side. It is usually necessary to trace the hypoglossal back to the point where it winds around the occipital artery so that the segment of the nerve for anastomosis with the facial will be sufficiently long to unite the two nerves without tension. The trunk of the hypoglossal is divided just distal to the thyrohyoid branch but before section of the hypoglossal is made the facial trunk should be divided and placed in position for anastomosis. The anastomosis is covered with the digastric muscle.

### CONCLUSIONS

The relief of facial spasm can be accomplished only by the infliction of the penalty of facial paralysis. The features of this paralysis should be carefully explained to the patient before the operative procedure is undertaken.

Although the effects of nerve anastomoses in the treatment of facial paralysis are well known, the final results of such anastomoses for the relief of facial spasm seem to have received little attention.

The paralysis necessary to the permanent cure of facial spasm should be relieved and this is possible by anastomosing the facial with the hypoglossal or spinal accessory nerve. This procedure offers the only chance of satisfactory relief of facial spasm.

REFERENCES

- <sup>1</sup> Harris, Wilfred, and Wright, A Dickson Treatment of Clonic Facial Spasm Lancet, 1, 657, 1932
- <sup>2</sup> Gibson, A Surg, Gynec & Obstet, 33, 472, 1921
- <sup>3</sup> Parker, Harry T Bilateral Facial Spasm, Paraspasme Facial Bilateral of Sicard Am Jour Ophth, 16, 28, 1933
- <sup>4</sup> Coleman, C C Surgical Treatment of Facial Paralysis Transactions Sou Surg Ass'n, 1921 Reprinted from Va Med Monthly, July, 1922
- <sup>5</sup> Kennedy, R Phil Trans Roy Soc, 194, 152, 1901
- <sup>6</sup> Leriche, R Lyon Chir, 25, 10, 1928
- <sup>7</sup> Sicard, Robineau, M, and Haguenau Rev Neurol, 1, 343, 1927
- <sup>8</sup> Adson, A W Personal Communication

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## DIRECT ROENTGEN RADIATION OF BRAIN TUMORS DURING OPERATION

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SOME brain tumors—the meningiomata—are perfectly encapsulated and can be completely removed, and there are some types of gliomata that can be similarly treated. There are, however, a good many gliomata, fully 25 per cent, that are likely to recur even after they have been apparently completely removed. A very few of this type have been permanently cured. Some have had relief for several years but sooner or later they recur. How to cure these cases has given neurologic surgeons much concern.

In the hope of destroying any tumor cells that may have been left, roentgenologists have been using larger and larger doses of roentgen radiation. These have undoubtedly been effective in retarding a tumor's growth. One type of glioma—the medulloblastoma—is particularly susceptible to the roentgen ray, as was first pointed out by Sossman, working with Cushing, a number of years ago. Brain tumors, however, develop a resistance to this type of radiation and, though their growth may be retarded, up to the present time a cure has not been effected. Our practice has been to give as large an initial dose as possible in the hope that any cells that have been left may be destroyed. The obstacle to extremely large doses has always been the danger to the skin and bones of the skull.

Several years ago Drs. Sherwood Moore and Vilhay Blair<sup>1</sup> began treating malignancies of the neck by administering the roentgen radiation directly into the open wound during the course of the operation. Doctors Moore and D. K. Rose<sup>2</sup> have done similarly in cases of carcinoma of the bladder. The results in both types of cases, malignancies of the neck and carcinoma of the bladder, were so encouraging that Doctor Moore has been urging me to try the method on cases of brain tumor. We knew that the normal brain tolerates a good deal of roentgen radiation and we had given as much as 600 R (measured in air) at one treatment per day, given to each of two to four areas.

In June, 1935, at a meeting of the American Neurological Association, in considering the results of the roentgen treatment of 119 gliomata,<sup>3</sup> I suggested that "Larger doses of roentgen radiation should be used in the treatment of tumors of the brain," and stated that one method would be to devise "a safe method of giving therapy into an open cranial wound, thus avoiding the danger to the scalp and bone flap and delivering a much larger quantity of roentgen radiation into the tumor bed."

In 1936, a boy presented himself from whom we had removed a medullo-



# ROENTGEN RADIATION OF BRAIN TUMORS

Fig 1—Showing the manner in which the patient is draped, with heavy lead covering the bone and skin margins. This entire area is then covered with two sterile sheets, and the area to be rayed is marked on the sheet with a colored pencil



Fig 2—Deep therapy being applied. The cone of the tube is placed directly over an area marked on the sheet, corresponding to the skull defect



blastoma two years previously. Whenever his symptoms recurred, roentgen therapy checked them, so that we knew we had a very radiosensitive tumor. Finally we reached a point where his skin would tolerate no more radiation. This was our first opportunity to try the new method. His old wound was reopened May 25, 1936, and all vestiges of tumor were removed. Fortunately, there were no visible signs of subarachnoid implants which are so frequently found at a secondary operation for this type of tumor. With the wound open and all bone and skin heavily protected with four layers of lead, after suitable sterile towels had been placed over the wound, he was given 4,000 R. His wound healed without any reaction and he was discharged in less than three



FIG 3—A wound, two weeks after deep therapy had been applied, showing perfect healing.

weeks. We could discover no symptoms after operation indicating any interference with cerebral function so that we feel justified in concluding that this large dose had no ill effect on the normal brain tissue.

Since then, we have treated eight other cases of brain tumor similarly. One, a little boy, who also had a medulloblastoma, received 2,500 R, due to his restlessness we could not give more. Two other patients, who had a spongioblastoma multiforme, which is the type of tumor that gives us the greatest concern since it is not as radiosensitive and has a great tendency to recur, received, 4,000 and 5,600 R, respectively. Cases that have been operated upon some time ago we must treat in this way. We have realized that none of these cases was ideal for this type of treatment since they had all had a large amount of roentgen radiation to the tumor bed through the

skin and bone, and therefore the tumor might well have become radio-resistant

The ideal way in which to apply this method is, of course, at the time of the initial operation and not at a second one. This is the method we are now employing whenever possible. We have had, to date, five cases, in each of which we have given 6,000 R, *without any filter*, directly into the wound during the course of operation. In four of these the K V used was 85 and in one 165. All these patients tolerated this huge dose very well and have shown no untoward after-effects. Their wounds have healed without any disturbance whatsoever. To prolong a patient's operation naturally was a matter of much concern. In our earlier cases the time of exposure lasted as long as one and a half hours. Doctor Moore has, however, by using *no filters whatever* cut the time down so that he is able to give 6,000 R in from 30 to 40 minutes.

We make no claims for this new method as yet, but merely wish to present it. If roentgen radiation is going to help in stopping deep seated, malignant growths of the brain, huge doses must be used, and this method makes it possible to give doses far in excess of anything that has previously been possible. We want to reemphasize the fact that these large doses have apparently had no harmful effects on the patient.

We hope to make further reports on this method after sufficient time has elapsed to determine end-results.

#### REFERENCES

- <sup>1</sup> Blair, V. P., and Brown, J. B. The Treatment of Cancerous or Potentially Cancerous Cervical Lymph Nodes. *ANNALS OF SURGERY*, 98, 650-661, October, 1933.
- <sup>2</sup> Rose, D. K. An Immobilizing Retractor Which Allows Direct Exposure of Bladder Carcinoma to X-Ray Therapy. *Jour Urol*, 33, No. 6, 664-668, June, 1935.
- <sup>3</sup> Sachs, E., Rubenstein, J. E., and Arneson, A. N. Results of Roentgen Treatment of a Series of One Hundred and Nineteen Gliomas. *Arch Neurol and Psychiat*, 35, 597-615, March, 1936.

## THE TREATMENT OF BRAIN TRAUMA

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SWIRT<sup>1</sup> states that there are approximately 112,000 cases of skull fracture occurring annually in the United States with an average mortality of 25 per cent. Woites and Foster Kennedy report a mortality of 37.8 in 1,000 cases of cranial injuries admitted to the Bellevue Hospital between 1920-1925. Fred Besley, of Chicago, in a report published in 1916 by the Cooke County Hospital, regarding 1,000 consecutive patients having fracture of the skull, states that the mortality was 53 per cent. When we remember that during the Great War the United States had 36,694 killed and that 13,691 died of wounds, or a total of only 50,385 deaths in battle, we must realize what a serious calamity to our country the mounting death rate from accident is. Many statisticians believe that approximately 125,000 injuries involving the cranium and its contents occur in the United States annually.

My object in presenting this subject is not so much to attempt to bring out something new in the treatment of brain trauma but rather to give a brief resume detailing the treatment of such cases over the period of the past 25 years, hoping that it may aid in giving information and encouragement to many doctors throughout the United States who are called upon, only occasionally, to treat and manage acute traumatic brain lesions.

Primarily, these patients should be treated where they receive the injury, if possible, because to move them roughly might cause death. Immediate treatment by the local doctor for the shock is often life saving. We have had brain trauma cases brought to our clinic in automobiles, with death resulting soon after admission, the patients not having been critically injured, apparently, but they could not, however, survive a 25 mile auto trip.

The neurosurgeon treats a very small percentage of these cases of traumatic brain lesion. If he could, the mortality and morbidity would unquestionably be markedly reduced. We are greatly indebted to these specialists for their teachings and for the industrious research work that they have accomplished. It is to be regretted that the profession generally is not better informed regarding their efforts, although I wish that they themselves might agree more fully as to the best method of treatment for these cases.

Within a radius of 120 miles of Chattanooga, there is a population of approximately a half million, and there is not a neurosurgeon living within this area, which shows the necessity of a better understanding by the general profession of how these cases should be managed. Doubtless there are many other such areas in the United States which are devoid of these specially trained men.

In 1922, I<sup>2</sup> reported that "We have treated in our hospital during the past five years 68 cases of serious brain injuries that we have tabulated. We

have not included all the brain injuries that we have received into the hospital, as some were moribund when brought in and died within a few hours, and some which were never serious were not included, but we have included all the brain injuries that were operative, some of these were deeply unconscious and grievously ill at the time of operation. The nonoperative brain injuries were usually the ones with linear fractures, or no fracture, intracranial pressure not high, either not unconscious or only moderately so, and no focal symptoms of localized hemorrhage, and no depressed fractures—the class of case that without complication and without other injuries should recover.

“There were 45 operative cases of brain injury—subtemporal decompressions—with 14 deaths (31 per cent mortality). These were the most serious cases of the series.

“There were 19 cases not operated upon, with five deaths (26 per cent mortality). Three of these deaths occurred suddenly and were unexpected, two were treated by repeated spinal punctures to relieve the increased intracranial pressure—both recovered.”

It is possible that the three unexpected deaths were due to the late effects of spinal puncture, as in this era of our work we performed spinal taps in all cases where we suspected a marked increase of intracranial pressure.

The headaches, restlessness and mild unconsciousness resulting from intracranial pressure when not relieved by dehydrating measures, are often relieved by drawing off from ten to 25 cc of spinal fluid, under the control of a manometer, not allowing the pressure to go below ten to 15, which has, occasionally, been spectacular in its favorable results. As a result of the teachings of many neurosurgeons, we have the utmost respect for spinal decompression by withdrawing the spinal fluid in cases of traumatic brain injuries, and it is most probably due to this respect that we have not had any deaths, to our knowledge, following this procedure.

In order to determine the results of our present method of treatment as compared to those obtained over a 15 year period earlier, an analysis was made of the last 100 consecutive cases coming under our care. In this series were included those which survived two hours or longer after admission to the clinic. In 56 per cent of the entire series the injury was due directly to automobile accidents. The next most frequent cause were the results of industrial accidents (25 per cent). Fights, during which blows on the head were administered by various weapons, were responsible in 12 per cent, and falls, causing cranial trauma, accounted for the remaining eight per cent.

It has long been our contention that the way these cases are handled by laymen immediately following the accident has a most important bearing on their condition. All of us are familiar with the totally unconscious patient, who on recovering from the initial shock, lying quietly and breathing normally, is moved roughly, or has his head raised quickly, the patient begins vomiting and straining immediately, respiration becomes rapid, and it is several minutes before they recover. In 88 per cent of this series, trained ambulance attendants brought the patients to the hospital, and we feel that

the subsequent recovery of many was due to their proper and careful transportation

Our first concern with the brain trauma case is the determination of the presence or absence of shock. The grave possibilities of this feature are, far too frequently, not appreciated. Shock was present in 36 per cent of this series. No examination or manipulation of any kind was attempted until definite recovery from this condition. The usual measures are employed, with stress placed on absolute quiet, warmth, one-fourth grain morphine hypodermatically and intravenous injection of 50 to 300 cc of from 10 to 50 per cent glucose.

We do not attempt, at first, to classify our cases according to the type of pathology present, but try to consider the clinical signs and symptoms as a whole in regard to the method of treatment indicated.

In 75 per cent of this series the clinical syndrome present was that described by most authors as concussion. It is not within the province of this paper to discuss the many and varied theories as to the actual pathology present in this condition. We are content to use the word concussion by preference, as the laity and the legal profession know what we mean by concussion. This clinical syndrome is usually characterized by very temporary unconsciousness, or an unconsciousness lasting several hours, followed in some cases by vomiting, severe headache, and vertigo. Recovery is prompt and complete under proper management. Absolute quiet, with rest in bed, is essential to allow the proper readjustment of cellular and fluid content of the brain. When possible, these patients are kept in bed ten days. We feel that this usually shortens the period of disability because recovery from headache and dizziness is far more prompt. It is our practice to give these cases magnesium sulphate by mouth on the second or third days. We use codeine and luminal in small amounts for pain and restlessness. A light diet is allowed during hospitalization.

In the more severe type of brain injury, the symptoms and signs are variable. It is imperative for the attending physician to be able to correctly correlate his findings, in order to properly undertake treatment. In this type of injury, many authors attempt to classify each case separately, as laceration, contusion, edema or hemorrhage of the brain. Any severe force applied to any portion of the cranium is transmitted with very little loss through the entire quantity of the contained fluid. So that trauma over a lateral ventricle may very well cause multiple petechial hemorrhages in the fourth ventricle, or in the cisterna magna or cisterna basalis. Obviously, then, most cases of severe brain trauma are a combination of two or more of the previous named types, namely, laceration, contusion, edema, or hemorrhage.

Of the 100 cases, 25 were considered as severe brain trauma cases, and of this 25, 20 were considered as severe combined injury to the brain. Following recovery from shock the patients were carefully examined. There are a number of signs and symptoms which must be evaluated in order to determine the best method of management. To us, the most valuable of these have been the

following (1) The stage of consciousness, (2) stage of restlessness, (3) the pulse, (4) the temperature, (5) the respiration, (6) the blood pressure, (7) the presence or absence of paralysis, (8) pupillary changes, (9) bleeding, and (10) multiple injuries

An accurate notation of each of the above items, at the first examination of a brain injured case, affords a most excellent method of observing what changes occur in the patient's condition during the hours, or days that follow. All of these 20 cases were unconscious when brought to the hospital. A change in the stage of consciousness is probably the most important single item indicating the patient's progress. Restlessness, present in 55 per cent, is always a bad sign, to us, it indicates a general cerebral irritation either from a marked edema, diffuse bleeding, or extensive contusion. The rate and quality of the pulse should be carefully noted. A very slow pulse, as a rule, indicates an increase in the intracranial pressure. Following recovery from shock, it is our experience that a very rapid pulse is a grave prognostic sign. High temperature following shock is usually an indication of impending disaster. Rapid respiration is also a bad prognostic sign. A record is kept of blood pressure changes, but, to us, has not afforded as accurate an index to cerebrospinal fluid pressure as some authors claim. The presence of pupillary changes or paralysis usually indicates a localized lesion and will be discussed later under operative indications. Bleeding from the nostrils or ears was present in ten instances. This, at times, indicates basal fracture and severe brain damage. Multiple injuries complicated brain trauma in 44 per cent of the 100 cases. Great care must be used in treating these injuries in the stage of serious cerebral embarrassment. It is much better to delay treatment until partial recovery has occurred.

As a diagnostic aid, the roentgenologic examination is of prime importance where a depressed fracture is suspected. In cases where there is no depression we do not feel that a roentgenogram of a fracture of the skull is of great value, but it is of importance in diagnosing brain injury, as certainly a fracture running through the middle fossa is of far more importance than one involving the anterior fossa. However, we do not insist on roentgenograms being made until the patient is well able to withstand the procedure. Most of our examinations are taken by a bedside unit, with the patient in bed, and it is our practice to make them where no real injury can result to the patient, not only because of their diagnostic value, but also to complete the record, and for medicolegal purposes.

With us it is frequently difficult to convince the patient that he is seriously injured and should remain in the hospital under constant observation, unless we can definitely assure him that the roentgenogram shows he has a fractured skull.

The severe brain injuries in this group were all treated conservatively. They were put to bed immediately and absolute quiet demanded. Intelligent and well trained nurses were kept in constant attendance. It is rare that we

put these restless cases in a strait-jacket as we have found that the restriction irritates the patient and increases his irrationalness and uncontrollability

The value of strong solutions of intravenous glucose is questioned by many competent authors. However, we feel that the physiologic reasons for the use of these solutions are well founded. Solutions of glucose ranging from 25 to 50 per cent in strength and usually from 50 to 100 cc in amount are given to our patients every four to six hours. We feel that these injections are of definite value, and there have been no recorded ill effects from their use. Sedation was satisfactorily accomplished, in most cases, by the use of sodium luminal in five grain doses, either intramuscularly or intravenously. No concern is felt in giving large doses when necessary. Morphine, after the initial injection for shock, is not used because it is feared that it masks any symptoms that might develop and further depress an already embarrassed respiratory center. Small pledgets of sterile cotton saturated with alcohol are placed in the external auditory meatus when there is bloody discharge. Bleeding from the nostrils usually stops quickly, however, on two occasions it was necessary to pack the nostrils to control it. The packing is effected with vaselized gauze as it causes so much less trauma in removing than does dry gauze. This is a dangerous procedure as it is likely to lead to infection and resulting meningitis.

While spinal puncture is a very important diagnostic and therapeutic aid, we do not feel that it is indicated routinely. Our experience indicates that the indiscriminate withdrawal of cerebrospinal fluid does far more harm than good. When the patient exhibits extreme restlessness, marked slowing of the pulse, rapid respirations, or increasing unconsciousness, indicating advancing edema or diffuse hemorrhage, we employ spinal puncture for both diagnosis and treatment. This, however, was done in only five cases in this series. On one occasion, repeated punctures were considered necessary, each time bloody fluid was obtained, and it was felt that the withdrawal of this blood hastened recovery.

Liquids in moderation are administered to the patients by mouth as soon as they will swallow them when placed on the tongue. Magnesium sulphate in two to three ounces of a 50 per cent solution is given by mouth or by rectum on the second or third day, and is repeated frequently to aid in dehydration.

These patients have frequent daily observations made while they are hospitalized. Further treatment depends on the daily change in signs and symptoms. Usually these cases will need catheterization for the first 24 or 48 hours, following which they void involuntarily at irregular intervals. It was interesting to us to note that in the 25 severe cases the average time of unconsciousness was 5.7 days and the average period of involuntary micturition was 5.2 days. When these patients void voluntarily we feel much easier about their condition. All severe head injuries are kept in the hospital until they are fairly well conscious and oriented. The average period of hospitalization in this group was 17 days.



A small percentage of head injuries offers different indications for operative interference. The most outstanding of these, of course, is decompression. This type of fracture may be accompanied by numerous complications, such as compound injury of the scalp, severe comminution of the bone, or direct laceration of the brain and meninges.

It is our usual method, in recent depressed, compound injuries, to débride thoroughly, remove all small unattached bone fragments, wiping away contused brain tissue with moistened cotton pledgets, control bleeding from the brain with fine silk ligatures or silver clips, close the dura with fine silk and repair the scalp in layers without damage. In probably infected cases, we simply cleanse and débride the wound carefully and thoroughly, repair the dura and pack the scalp edges lightly with vaselized gauze. A secondary closure is effected later if no infection develops. Should there be no scalp injury present and if the patient presents no symptoms of pressure, we wait several days before elevating the depression. All of these operations are performed under 1 per cent novocain anesthesia.

The other indication for operative procedure is localized severe extradural hemorrhage, usually encountered following injury to the middle meningeal artery. The syndrome described in text-books is usually easily recognizable but unfortunately is seldom present. Without deviations, the lucid interval after injury followed by unconsciousness, dilatation of the ipsilateral pupillary paralysis of the contralateral extremities, decreasing pulse rate, *etc.*, may all be present in these cases and do constitute operative indications. However, it has been our experience that it is usually a diffuse injury to the brain which accompanies the above picture, and complications should be guarded against in most instances. In several cases in which I have operated, a tense dura was found, and almost clear cerebrospinal fluid, under great pressure, spouted up when the dura was incised. Such cases are usually quickly relieved, as a rule, simply by relieving the pressure.

Of the group of 25 severely injured patients, six came to operation. Four of the five depressed fractures were elevated with excellent results. The fifth was a very slight depression in the temporal region and operation was not judged necessary. In two cases a diagnosis was made of middle meningeal hemorrhage and exposure of the involved area was effected under local anesthesia. In each instance, extensive laceration and contusion of the brain substance were found and both cases succumbed a few hours later.

Of the 100 cases in this series, there were five deaths, a mortality of 5 per cent, and in the severely injured cases, 20 per cent. All of these cases died within 96 hours following injury. The two cases on whom decompression was performed for extradural hemorrhage had evidence of severe contusion and laceration of the brain and in two of the remaining three cases we did not feel that any type of treatment would have helped. One of the cases included in the mortality list was very interesting and instructive to us. A young, robust man received a moderate blow on the left parietal region, with the small end of a billiard cue. The outer layers of the scalp were split for

approximately one and one-half inches. The patient walked five blocks to the emergency room, the laceration was dressed and he returned to town where he remained four hours before walking one and one-half miles home, where he went to bed. The following morning, at 7 A M, a reporter was calling the clinic asking rather embarrassing questions about who treated the man who was found dead in bed at 6 30 A M.

Of the 20 patients surviving severe head injury, accurate follow up records have been obtained in 16. Eleven of these write that they are entirely free of symptoms in any way pertaining to their injury, three of the patients complain of headaches, vertigo, and weakness. Without exception these symptoms occur following exposure to heat, excitement, or undue exertion. Small doses of luminal are very valuable in such instances. In one case there was a permanent paralysis of both external recti muscles. One patient who had a severe injury to the scalp and brain has definite character and personality changes, with convulsions following exposure or excitement. This incidence of sequelae corresponds very well to that reported in the literature by other authors. Patients with definite convulsions, at times, require the services of a skilled neurosurgeon, but, as a rule, very little can be done to alleviate their complaints.

Alton Ochsner<sup>3</sup> states that "In the Charity Hospital series, which we studied, very few operations were performed and the results obtained in this group demonstrate the value of conservative treatment. In the decade from 1910-1919, only 5.2 per cent of the cases were operated upon, the incidence of operation decreased in the next decade to 1.6 per cent, and in the two years, 1930-1931, the incidence of operation was 0.5 per cent. In the entire series of 1,099 cases only 31 operations were performed, an incidence of 2.8 per cent. The value of this ultraconservative treatment is shown by the results obtained in our series. In the entire group of 1,099 cases there were only 92 deaths, 8.4 per cent. If one excludes those cases dying within the first 24 hours, in which probably relatively little could be done, because of the extensive injury, there were only 43 deaths, a mortality rate of 3.9 per cent. The mortality rate in the operative cases was 25.8 per cent, whereas, that in the nonoperative cases was 7.8 per cent."

I do not believe that the 53 per cent mortality rate reported by Besley from Cook County Hospital, and the 3.9 per cent mortality rate reported by Ochsner represent the difference in treatment, but rather represent the statistician's compilation. I do not believe that cases of concussion without complications should be included in any series representing the treatment and mortality of head injuries. Neither do I think that a case of skull fracture without hemorrhage or marked increase of intracranial pressure should be included in any such series, as practically no active treatment is indicated in either case. To properly evaluate the difference in mortality series under the various methods, only severe brain trauma cases should be included. In our series, reported in 1922, treated principally by subtemporal decompressions and spinal taps, our mortality rate was 31 per cent. In analyzing cases

reported 14 years later and treated by conservative methods, the mortality rate was 20 per cent. Both series were treated by the author personally and it is fair to say that the difference in treatment has reduced the mortality 11 per cent.

#### REFERENCES

- <sup>1</sup> Swift, G. W. Cerebral Injuries Due to External Trauma. Surg., Gynec., and Obstet., 62, 340, February, 1936.
- <sup>2</sup> Newell, E. Dunbar. Traumatic Brain Lesions. Trans. So. Surg. Assn., 1922.
- <sup>3</sup> Ochsner, Alton. Acute Craniocerebral Injuries. Am. Jour. Surg., May, 1931.

#### DISCUSSION OF THE PAPERS OF DOCTORS COLEMAN, SACHS, AND NEWELL

DR. JOHN T. MOORE (Houston, Tex.)—I have enjoyed all three of these papers, but I wish to make a remark about Doctor Sachs' paper regarding the direct application of roentgen therapy to these tumors and to suggest—I would like to see it tried—that the surgeons make more use of interstitial short wave roentgen ray and radium in the treatment of all malignancies. Using one and two milligram platinum needles properly placed, as a part of the operation, leaving them there two, three or five days, as you can safely do, would accomplish a great deal where radiation is indicated. I would like to have Doctor Sachs consider the use of these platinum covered needles at the site of his tumor as giving the most effective radiation. I am glad to see that we are using, more and more, the direct exposure of tissues to roentgen ray and radium radiation.

DR. KENNETH H. AYNESWORTH (Waco, Tex.)—I live in one of the districts Doctor Newell described, in the center of an agricultural district with a population of 250,000. In that district there are about 20 hospitals and four of these are in Waco. We have an enormous number of injuries to the skull and brain brought into these hospitals. That means that these patients receive the treatment that the ordinary surgeon would give.

At a meeting of our District Medical Society a year ago, a paper was read by one of our surgeons who suggested such radical measures that some of us older men thought we should combat them. He advocated taking each patient to the operating room immediately upon admission to the hospital and operating. I said there was not a neurologic surgeon in our district, and these patients should be put to bed and kept there as quiet as possible and that nothing should be done unless there was visible hemorrhage, which should be stopped by the easiest possible method and the wound, if there was one, treated, that the patient should be treated conservatively until a proper consultant could be called. By conservatively I mean without the use of morphine if possible. Since that time I have noticed a marked diminution in the death rate in these cases.

I had seen what I thought were bad results due to the moving, immediate roentgenographic examination and operation in these cases. Except in cases of serious hemorrhage, it occurred to me that operation was the wrong thing in the hands of the type of men who would have to perform it. Since we have adopted the conservative method of handling these patients, the mortality has dropped markedly. This gives us time to call in someone better qualified to handle the more serious cases, if and when necessary.

DR. ERNEST SACHS (St. Louis, Mo.)—It is very gratifying to see the general surgeons take such a lively interest in the treatment of head injuries,

for we have had that on our minds for many years. I think all surgeons are faced with the question of what to do. It is true, perhaps, that in certain details neurosurgeons differ somewhat, but I think we agree on the general principles. What was just said I think is very pertinent. First, not to be in a hurry about making roentgenologic examination of these cases. Second, to keep them quiet and not be in a hurry about treatment, especially about surgical procedures. In the majority of cases I think surgery is not indicated. I differ with some of my colleagues in that I believe the thing to consider is the treatment of the edema. You cannot do anything for a lacerated brain, but you can do something for cerebral edema. Those who have criticized the use of hypertonic solutions, either magnesium sulphate by rectum or the use of sucrose, I think are in error, for when given repeatedly this method undoubtedly reduces the cerebral edema. If the treatment is only used once the edema will recur and it must be repeated.

DR R. GLEN SPURLING (Louisville, Ky.) —So much might be said about head injuries that it is difficult to know where to begin and where to leave off. Doctor Newell's paper has summarized the subject clearly, concisely, and I think conservatively.

Attempts to lay down rules for the management of every case seem to me futile. I know of no other condition in medicine where a nicely weighed judgment is more important. I think too much has been said about conservative and radical treatment. As a matter of fact, the so called conservative measures may be extremely radical if improperly applied. The chief controversy seems to center around spinal punctures, operations and dehydration. In my experience, each one of these methods when thoughtfully applied is an important therapeutic agent. When done routinely they may be not only useless efforts but positively harmful. Careful neurologic observations will usually indicate those patients in whom these forms of treatment are indicated.

The term "edema of the brain" has been used entirely too loosely in the discussion of head injuries. Unfortunately, with the wave of enthusiasm over conservative treatment, many patients have been subjected to dehydration by every conceivable means early in their illness. I doubt seriously whether edema of the brain is ever early in onset. In an attempt to get some information on this subject during the past year we have taken routine spinal fluid pressures on all head injuries that entered the Louisville City Hospital. During the first 24 to 48 hours, high spinal fluid pressures are seldom recorded except in those patients who have a surgical complication (extra- or subdural clots, subdural hygroma or intracerebral clots). Most severe head injuries have a low or low normal cerebrospinal fluid pressure. To give these patients hypertonic solutions intravenously is to me definitely bad therapeutics. We keep the fluid intake at a moderately high level in such cases during the period in which the spinal fluid pressure is low. After 48 hours some patients do have increased intracranial pressure either from edema of the brain or from meningeal irritation from blood. In such circumstances dehydration is a logical and important phase of treatment. Of course, hypertonic dextrose should have been completely supplanted by hypertonic sucrose. Hypertonic dextrose is invariably followed by a secondary wave of edema from concentration of the dextrose in the tissues of the brain. With hypertonic sucrose this secondary wave is eliminated because the sucrose is not metabolized and is excreted in the urine as sucrose.

DR JOSEPH E. J. KING (New York, N. Y.) —I have enjoyed listening to Doctor Coleman's paper. It is the first good paper we have heard on this

subject. This most deforming, terrifying condition in an otherwise presentable individual who suddenly makes grimaces and monkey faces is very disheartening. Although I know nothing about the pathology, I think Doctor Coleman is right when he states that the pathology lies within the nerve itself and that it is not cerebral. Anastomosis of the involved branches of the facial with the hypoglossal seems to be more sensible than sectioning and resuturing the facial nerve.

I have had the good fortune to be acquainted with the late Doctor Duel and Doctor Tickle, who have done so much work on facial paralysis. They have obtained splendid results with transplantation. Doctor Tickle told me that for about six months or more everything looks all right, but after a while a number of the patients develop facial spasm. These patients had never had anything the matter with their brains, but the nerve had been injured at the time of a mastoid operation. Nevertheless, spasm followed transplantation of a section of nerve into the defect.

Doctor Sachs' use of radiation in cases of brain tumors directly into the open operative wound is certainly to be commended, and we shall most surely follow his suggestion. The danger of burning the skin has prevented proper radiation. It is common sense to believe that when a tumor has been removed, or partially removed, by morcellation, tumor cells are still in the neighborhood. It is inconceivable that all the cells can be removed, therefore it seems that the proper time to use roentgenotherapy is at the time of operation, and directly into the wound. We have never done this, but will attempt to do so hereafter.

I should like to say one word possibly in extenuation of the statistics presented by Doctors Kennedy and Wortis in the report which they made of craniocerebral injuries in Bellevue Hospital. This group included all types of craniocerebral injury regardless of their condition when they arrived, unless they were dead on admission. The group included all types of severe injury, and the cases were treated by a great number of men on the various divisions. The number of admissions is so enormous it is impossible for the neurosurgeons to handle them, so that they have been treated on the general surgical services. Recently these cases came under the control of Dr. Arthur Wright of the Third Surgical Division, and they are handled more specifically by Doctor McLean. I feel sure that the statistics to be reported hereafter will show improvement. Although a mortality rate of 35 or 37 per cent is rather high, I doubt seriously if, in a general hospital, one will be able routinely to obtain a mortality rate as low as 5 per cent.

DR. JAMES BARRETT BROWN (St. Louis, Mo.) —The patient Doctor Sachs referred to with carcinoma of the tongue was treated about 13 years ago by radical operation by Doctor Blair and by roentgen radiation through the open wound by Dr. Sherwood Moore. The patient lived seven years, but it is probable that the radiation had little to do with the cure of the disease. A few years ago, after many discouraging results in treatment of advanced malignancies of the neck, I asked Doctor Moore if he would consider treating these patients if the overlying skin was gotten out of the way for him. We did not have any very good results, but, now, after further observations, Doctor Moore thinks the plan might be more successful. Dr. D. K. Rose and Doctor Moore adopted the method of open radiation for tumors of the bladder and obtained some good results. The difference is, that here a primary growth is treated instead of a metastatic one as we started to do in the neck. The same thing applies in Doctor Sachs' work, where he is treating primary metastatic tumors in the brain, and some excellent results may be expected. Last week, in a patient, whom I operated upon for Doctor Blair, with an infiltrating basal

cell growth of the forehead and frontal sinus, I removed the remaining fragments of the frontal bone, and Doctor Moore gave 8,000 R at one time—directly over the frontal region—the patient left the hospital in good condition without any known cerebral symptoms resulting from the treatment

DR CLAUDE C. COLEMAN (closing) —I have been asked about the success of faciohypoglossal anastomosis. This anastomosis is uniformly successful in restoring motion to the paralyzed muscles, provided it is performed before these muscles are completely atrophied. The restoration of facial expression is limited after this operation but its success in this respect depends to a great extent upon the patient's efforts at reeducation. The facial nerve has a high capacity for regeneration.

In my experience, faciohypoglossal anastomosis, a few years ago, was nearly always required because of paralysis due to mastoid infection or following mastoid operation in which the nerve was traumatized. At the present time faciohypoglossal anastomosis is more frequently required because of an intracranial destruction of the nerve due to complete removal of cerebello-pontine angle tumors. It is rarely possible to save the nerve when the capsule of these tumors is completely removed, although in a recent case a large tumor was removed with preservation of the nerve and restoration of its function after a temporary paralysis.

I have been very much interested in a nerve graft operation of Ballance and Duel for the relief of facial paralysis and I want to thank Doctor King, both for the remarks about my paper and for his reference to the Ballance-Duel operation. Nerve graft operation is not applicable in the treatment of facial spasm or in paralysis following removal of an angle tumor, but good results have been reported from nerve graft when the nerve is injured in the facial canal.

A careful explanation should be made of the patient with facial spasm before any operative procedure is begun, whether for simple section of the nerve, injection of alcohol or faciohypoglossal anastomosis. The details of facial paralysis should be carefully explained, giving due attention to the effects on the eye and other features of the penalty which the patient must pay for the relief of the spasm.

I want to emphasize that in view of the fact that paralysis is necessary for the cure of facial spasm, this paralysis should be treated precisely as that following removal of angle tumors, that is, by faciohypoglossal or facio-accessory anastomosis. Changing the innervation by substituting one of these cranial motor nerves for the proximal portion of the facial should relieve the paralysis without recurrence of the spasm.

DR ERNEST SACHS (closing) —Regarding Doctor Moore's question about the use of radium, for a year and a half before we began using roentgen radiation we tried planting radium emanation all around, implanting as many as 25 seeds in the wall from which the tumor had been removed, and we have only one case that is still symptom free over two years. We found the method so unsatisfactory that we were glad to make use of the opportunity which Doctor Moore of St. Louis gave us of trying this other method, which I hope will be more successful and effective.

# ANEURYSM IN THE CERVICAL PORTION OF THE INTERNAL CAROTID ARTERY

AN ANALYTICAL STUDY OF THE CASES RECORDED IN THE LITERATURE  
BETWEEN AUGUST 1, 1925, AND JULY 31, 1936

REPORT OF TWO NEW CASES

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SINCE extracranial aneurysm of the internal carotid artery is a notoriously treacherous lesion and especially since no surgeon has had a wide experience with the condition, the completion of its history together with an account of two hitherto unpublished cases may not be amiss at this time

The first case of aneurysm in this part of the carotid system was observed by Sir Astley Cooper,<sup>14</sup> in 1808 For a long time, further observations filtered into the literature very slowly, but of late the occurrence of aneurysm in this situation has been noticeably on the increase and the affection has ceased to be a novelty Thus, as recently as 1906, Bobbio<sup>5</sup> could muster only 18 cases, whereas, exactly 20 years later, one of us (N W)<sup>68</sup> was able to compile a series of 106 cases In the meanwhile, counting the two cases herewith presented, 18 additional observations have found their way into current medical periodicals Altogether this makes a total of 124 examples of extracranial aneurysms of the internal carotid artery on file The condition is, therefore, occurring in sufficient numbers to demand the utmost caution in dealing with affections of the throat

In speaking of arteriovenous aneurysm between the internal carotid artery and its satellite vein, von Bergmann<sup>4</sup> states that it is a rare lesion and cites only two cases, those of Gualdès<sup>25</sup> and of Joiet<sup>38</sup> Callander<sup>8</sup> in a more recent communication adds 10 additional cases However, two of these cases (Chartier,<sup>11</sup> and Quénu's<sup>55</sup>) are fistulae between the primitive carotid and the internal jugular vein and do not belong in the group under investigation Winslow<sup>68</sup> cites 19 observations in his paper Of these cases only three were recorded prior to 1900

We attribute the increased incidence of aneurysms in this part of the carotid system to the introduction of the high-velocity, steel-jacketed bullet which cuts its way through vessels and does not push them aside as is the case with the slowly moving lead ball

The chief interest in the condition, however, does not reside in its comparative rarity Of greater import to the clinician is the possibility of its being mistaken for a tonsillar abscess from its penchant for appearing in the



neighborhood of the tonsil, with little or no manifestation of its presence in the neck. As a consequence of this peculiarity, the unwary physician has lanced an aneurysm of the internal carotid artery, on occasion, for abscess, with the consequent death of the patient from hemorrhage.

Blunders of this sort are historic. Chassagnac,<sup>12</sup> Liston,<sup>41</sup> Vas,<sup>64</sup> Lee,<sup>39</sup> and Schlagenhaufen<sup>59</sup> have made this mistake. The patients of Minich,<sup>47</sup> Wulff,<sup>69</sup> Reid and of Winslow had similar experiences, but others than the authors committed the error. In the case reported by Minich, a bewildered physician lured by the appearance of the swelling incised it for an abscess and to his amazement was greeted with a gush of blood instead of pus. The bleeding was arrested with difficulty, but two days later a fatal hemorrhage occurred. Soon after the apparent recovery of Wulff's patient from an attack of angina, a physician noticed a tonsillar bulging which he cut for an abscess, but only blood escaped. The tumor soon returned and pulsated. Wulff, suspecting it to be an aneurysm, inserted a needle into the swelling and aspirated pure blood. Ligation of the primitive carotid cured the condition. Winslow's patient had a mass in the right side of the throat. Her doctor thinking it to be an abscess, lanced the swelling and evacuated blood but no pus. Much to the woman's chagrin, the lump continued to increase in size. Ligation of the right common and external carotid arteries effected a cure.

Wagner<sup>67</sup> was spared the humiliation of cutting into a swelling of the same character by neglecting to take along with him his instruments. When he returned, he learned much to his surprise that the patient had died of a hemorrhage into the mouth. Duke<sup>19</sup> barely avoided a similar disaster. He was about to open a supposed abscess in a patient's mouth when he detected an aneurysmal pulsation in the tumor. A consultant did not consider the condition so serious and lanced the swelling. There was a gush of blood, the arrest of which necessitated ligation of the primitive carotid. The patient died later of a secondary hemorrhage. Zamboni<sup>70</sup> was saved from a like catastrophe by his patient's refusing to be operated upon. Johnson<sup>35</sup> nearly committed the same blunder when he attempted to lance the swelling in his case, but had to desist on account of the child's unruliness. An associate of Helman's<sup>29</sup> intended to open such an aneurysm for an abscess. He sent the woman to the clinic for demonstration but advised her to return to have the swelling opened. According to Helman, the condition at first glance might have been mistaken for a tonsillar abscess, but its long duration, absence of pain and lack of inflammatory signs were against such a diagnosis, besides, the swelling was actively pulsating in unison with the radial pulse. A colleague suggested that a trocar be inserted to verify the diagnosis, a procedure which Helman deemed neither expedient nor safe.

An accident no less serious than meddlesome surgery is spontaneous rupture of the aneurysmal sac into the mouth. This catastrophe follows failure to recognize the condition or to ignorance concerning its proper



treatment In the case reported by Pircher,<sup>54</sup> an external swelling was diagnosed as a cervical abscess The patient's jaws were fixed and she could not open her mouth Pircher made an incision in the neck but failed to reach the suspected pus He thereupon called in consultants who agreed with him that the lesion was an abscess and advocated the insertion of a trocar This procedure also failed to yield the desired result The child died suddenly of a copious hemorrhage into her mouth The symptoms were so obscure and misleading that Pircher completely failed to suspect the real nature of the affection, and he believed, until the death of the patient, that he was dealing with an abscess At no time did he seem to sense what the trouble was and he was unable to account for the origin of the bleeding It was only at autopsy that he became aware of the character of the lesion Perier<sup>52</sup> considered the condition so perplexing that he was unable to decide upon the true character of the malady in a case under his care The patient succumbed to a profuse hemorrhage from the mouth Neuffer's<sup>50</sup> patient died of a spontaneous hemorrhage from the mouth Autopsy showed an aneurysmal dilatation of the internal carotid artery with an opening leading into the pharynx Coomes,<sup>13</sup> Velebil,<sup>65</sup> Beck,<sup>3</sup> Booth,<sup>6</sup> Heaton,<sup>2</sup> Hirsch,<sup>30</sup> Klarfeld,<sup>44</sup> Stumpf, Tollet, and Ortmann lost their patients in the same way

Generally speaking, the symptoms are frank and not, as some observers would lead us to believe, obscure Cases similar to those just cited are the exception and not the rule On inspection of the throat, the examiner sees a bulging in the lateral pharyngeal wall The aneurysmal tumor may be circumscribed or it may be diffuse To the touch it is soft and elastic, and pulsates throughout its entire extent The swelling may, on occasion, so encroach upon the fauces as to convert the alimentary tract at this point into a narrow slit With but rare exception the pharyngeal protrusion is accessible both to sight and to touch Occasionally, however, the jaw is locked and the condition of the throat is neither visible nor palpable (Neuffer, Pircher) Externally there may be no evidence of the disease, or there may be a boggy mass or a distinct lump behind the angle of the jaw (Porter,<sup>56</sup> Godfray,<sup>26</sup> Polak,<sup>55</sup> Jianu,<sup>34</sup> McMullen and Stanton,<sup>46</sup> Henle in Lebram, Stumpf, Blair in Brown, and Campbell With a stethoscope placed over the swelling a bruit may be heard Both murmur and pulsation disappear when the common carotid artery is compressed against the vertebral column, to reappear immediately on release of the pressure Arrest of the circulation through the affected vessel causes a diminution in the size of the aneurysm The patient may complain of annoying buzzing noises in the ear, persistent and severe hemiparesis, vertigo and weakness Swallowing of solids is sometimes impossible and is generally accomplished with difficulty Liquid food may be regurgitated Dyspnea is a common complaint

It is a well recognized fact that aneurysm of the internal carotid artery rarely points in the neck On January 22, 1808, Sir Astley Cooper<sup>14</sup> ligated the common carotid artery for what he believed to be an aneurysm of the

internal carotid artery Inasmuch as the manifestation of the swelling was in the neck and not in the pharynx, the case has been classed by some writers as an aneurysm of the primitive trunk and not of the internal branch In justification thereof, these critics assert that aneurysm of the internal carotid presents in the throat, never in the neck, while aneurysm of the common carotid occupies the neck, never the throat They claim that in this peculiar behavior lies the chief difference between aneurysm of the internal carotid and one situated on the common trunk Generally speaking, this is true Yet at operation and at autopsy, instances of aneurysm of the internal carotid artery have been observed without any swelling having appeared in the throat Prewitt,<sup>57</sup> Agnew,<sup>1</sup> Pircher, Sércey, Mensing and Regan, and Shipley, Winslow and Walker<sup>60</sup> have recorded observations of the kind

On the other hand, isolated examples of aneurysmal disease of the common carotid artery have been observed in which the sac projected into the throat Fehleisen,<sup>21</sup> in 1881, reported a case exhibiting this feature The patient, a male, age 34, was taken ill April 2, 1879, with an attack of angina, which was followed by a quickly increasing tense swelling under the right jaw, accompanied by cyanosis and dyspnea When admitted to the hospital April 7, the right half of the throat was red, swollen and definitely fluctuant On April 9, von Beigmann incised the swelling and evacuated coagulated blood Threatening asphyxia necessitated a tracheotomy, during the performance of which the patient died Autopsy revealed, at the bifurcation of the common carotid artery, a perforation that emptied into a sac on the inner side of the artery The sac was filled with clotted blood and at its upper end was a rent which communicated with the pharynx No pulsation was detected in the aneurysm nor was any bruit heard over it on auscultation

Equally as fallacious is the contention of those who assert that aneurysm of the internal carotid artery always presents in the throat, as thoroughly reliable operative and necropsy findings have been adduced to the contrary (Porter, Edmunds,<sup>20</sup> Polak and Moser<sup>40</sup>)

The absence of cervical swelling is explained by the dense cervical fascia in front and the cervical vertebrae behind crowding the gradually dilating sac inwards toward the tonsillar fossa where the weak superior constrictor muscle and the mucous membrane interpose but slight resistance to the progress of the sac Thus, the deep situation of the artery, covered as it is externally by the stylohyoid, stylopharyngeus, and the styloglossus muscles, and by dense aponeurotic tissues which extend to the styloid process, prevents any very marked prominence of such a tumor on the surface of the neck, and, as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle, it follows, as a matter of necessity, the lines of least resistance, pushes through the latter structures and bulges into the pharynx A factor that also influences the point of appearance of this variety of aneurysm is the height at which the common carotid artery

bifurcates If the carotidean bulb be situated at a high level, aneurysm of the internal carotid artery will point in the throat When the bifurcation occurs low in the neck, aneurysm in the internal branch is apt to appear in the neck

In isolated instances the pulse may be absent or so weak as to escape detection (Dubrueil,<sup>18</sup> Texier<sup>62</sup>) Johnson and Booth have each reported a case in which they were unable to detect any pulsation or to hear a bruit Under such circumstances, the aspirating needle has supplied the clue to the true nature of the lesion (Texier, Perthes in Keppeler,<sup>51</sup> Lyot et Petit,<sup>41</sup> Wulft, Zamboni in del Fabro, Cannuyt,<sup>9</sup> Hulbert<sup>33</sup> and Tollet) As diagnostic puncture leaves the aneurysmal wall weakened, aspiration should not be practiced unless the patient is so situated that a prompt operation can be performed if the sac should rupture through the path traversed by the needle It should be remembered, however, that a dry tap does not preclude the possibility of aneurysm, as the point of the needle may be entangled in, or the bore of the cannula may be plugged with, clot Instances of the kind have been recorded and the method is only of value when blood is obtained (Helferich in Werner<sup>28</sup>)

A recent diagnostic innovation of much promise is arteriography In obscure vascular lesions visualization of the arterial tree has established itself as a procedure of merit On at least two occasions, an extracranial aneurysm of the internal carotid artery has been detected by this method that might otherwise have been missed We refer to the cases reported by Terry and Mysel, and by Tonniss A puzzling feature of these two cases was the absence of a lump either in the throat or in the neck Under the circumstances, arteriography proved absolutely necessary to clarify the diagnosis as well as to fix the exact location of the lesion

Chronic unilateral swellings of the pharynx should be scrutinized with unusual care and especially so when the signs are lacking, obscure, atypical or bizarre, because a wrong diagnosis will almost certainly lead to mischievous surgery Dubrueil considered an aneurysmal tumor in this situation as either an adenoma or a sarcoma of the tonsil and attempted its extirpation During the progress of enucleation, the sac was torn Ligation of the primitive carotid arrested the bleeding, but the patient eventually died of an hemiplegia Helferich made the same mistake, but saved his patient by ligating the common carotid artery Gross,<sup>27</sup> in an effort to drive home the lesson of a correct appraisal of the condition, cites a case recorded by Syme<sup>61</sup> To stress his point, Gross naively adds "Had a less careful surgeon had the management of the case, he might possibly have punctured the tumor and thus hurried the patient out of existence"

The differential diagnosis of lesions in this region is in the main between aneurysm in the extracranial portion of the internal carotid artery and peritonsillar abscess and is to be determined upon the same general principles that apply in differentiating these affections elsewhere The history may

prove of much help in avoiding pitfalls. Mudd in Hulbert's case obtained a history of a lump antedating a scarlatinal angina and was thus led to a correct conclusion.

Agnew bases the making of a proper diagnosis on the ability of the surgeon both to see and to feel pulsation, but he fails to take into consideration the possibility of the patient being unable to open the mouth wide enough either for inspection of the throat or to permit the passage of a finger. Yet instances of the character have been recorded. The cases of Perier, Pircher and Neuffer serve to illustrate this point. However, failure to make a digital examination, when possible, is inexcusable.

Were this aneurysm more accessible, restorative aneurysmorrhaphy would be the ideal treatment. LeFort,<sup>40</sup> in a case of the arteriovenous type, incised the vein, sutured the hole in the artery and capped the line of suture with a section of the vein. The procedure proved successful. On the other hand, McMullen and Stanton lost the patient upon whom they performed an aneurysmorrhaphy. They thought that the operation had proved successful. The patient had been discharged from the hospital but had to return a few days later on account of the appearance of a hematoma beneath the scar. The wound was reopened and the source of the bleeding was found to be from a rent in the wall of the artery. Attempts to clamp the vessel failed owing to the friability of the tissues and the hemorrhage was controlled only with considerable difficulty by tamponing the wound. The woman had, however, lost so much blood that she soon died in collapse. This was an aneurysm of the arterial variety.

Morestin,<sup>48</sup> Moser, Bruns,<sup>7</sup> and Perthes<sup>53</sup> practiced extirpation of the sac. Agnew, because of recurrence of pulsation in the sac, ligated the opposite carotid, but the patient died about a week later of secondary rupture of the aneurysm into the mouth and of sepsis. Vander Veer<sup>63</sup> thought that he had obtained a cure by compression but the man fell dead three months later.

The operation of choice is ligation of the internal carotid artery proximal to the aneurysm. Should the internal carotid be unavailable for ligation, both the common and external carotid arteries must be tied along with any branches of the latter arising between the site of the ligation and the bifurcation. The latter provision prevents a possible reestablishment of the circulation in the sac by a reversal of the current through the open segments of the external and common carotids. Failure to observe this precaution explains the reappearance of pulsation in the sac.

Before permanently arresting the circulation in the internal carotid artery, the primitive trunk should be temporarily occluded under local anesthesia, to forestall the evil results incident to a disturbed cerebral circulation. Usually a defective circulation will manifest itself promptly by vertigo and by faintness. In the face of these warnings, the ligature should be removed without delay.

Competent authorities are agreed that ligation either of the common trunk or of its internal branch is not an operation to be undertaken lightly. Johnson<sup>36</sup> says that paralysis occurs in 15 per cent of the cases. According to DaCosta,<sup>17</sup> in from 20 to 25 per cent of the cases there is cerebral softening or some other intracranial mischief after ligation of the common carotid artery. Crile<sup>16</sup> states that, of the cases developing cerebral trouble, one-half of the patients die. The direct operative mortality according to him is 3 per cent. Horsley<sup>32</sup> asserts that the danger associated with ligation of the common carotid artery increases enormously after 40 years of age and is due to the diminished blood supply to the brain. On the other hand, he feels that ligation of the internal or of the common carotid in the young with elastic arteries is comparatively free from danger. In the opinion of this surgeon, cerebral symptoms vary from giddiness to complete hemiplegia.

As a security against undesirable symptoms, Jordan,<sup>37</sup> of Heidelberg, recommends a procedure which proved itself of value in an operation for carcinoma of the neck, namely, previous loose constriction of the carotid for 48 hours. By carefully constricting the carotid with a small, flat piece of tape until the peripheral pulse just ceases, there is no injury to the intima and no formation of clot. If the ligature be removed after two days, the peripheral pulse reappears and soon attains its normal strength.

Preliminary ligation should be performed under local anesthesia, so as to obtain prompt information of any effect upon the cerebrum. If disturbances occur after the constriction, the ligature is removed from the artery through the wound, which has been left open, and the circulation restored to normal.

By gradually tightening the ligature, an adequate collateral circulation may, on occasion, be developed from what was an inadequate one. This is also the teaching of Halsted, and is based on the toleration of the carotid to temporary occlusion. Crile has demonstrated that the common carotid artery may be clamped for 48 hours without permanently damaging the intima or causing thrombosis. Halsted employs aluminum bands for this purpose. It must be remembered, however, that cerebral symptoms may occur one or two weeks after ligation of these vessels. Matas<sup>45</sup> says "In the light of this important suggestion, no one is justified in planning a deliberate operation for the cure of aneurysm in this perilous locality without first testing the efficiency of the collateral circulation. The possible occurrence of cerebral disturbances has invested a simple technical procedure with a gravity associated with but few operations."

In passing we desire to report that Winslow's patient remains completely cured. It is now more than 14 years since the operation. The woman is enjoying good health and is working daily as a cook. The completed history of the case reported by Shipley and Lynn,<sup>60</sup> in 1916, is also available. The patient, a white married woman, age 52, was admitted to the University Hospital for the last time January 7, 1926, and was discharged January 24,

in an unimproved condition Eleven years before, her left common and external carotid arteries had been tied for an extracranial aneurysm of the internal carotid artery The aneurysm had not grown since then but had shrunk somewhat in size The patient, however, was being disturbed by noises in her head, throbbing sensations in her throat and severe headache Active pulsation was felt in the position of the primitive carotid over the point of the former ligation Shipley, therefore, decided to explore the site of the old operation to ascertain whether anything had happened at the place where the carotid had been tied It was thought that an artery was probably entering the sac from below and an operation was performed January 8, 1926, for the purpose of ligating this artery However, the artery was not tied because it apparently did not communicate with the sac The patient died in the summer of 1927, of a right-sided hemiplegia

These results would indicate that permanent arrest of the circulation through the internal carotid artery has little effect on the longevity of life in those individuals who have weathered successfully the initial storms incident to such an operation

Aneurysm in this situation is either true or false The true is that variety in which either one or all of the tunics of the artery enter into the composition of the sac The false is that type in which the wall of the sac is formed by adventitious tissue According to its etiology, this aneurysm may be classified clinically as (1) spontaneous, (2) erosive, and (3) traumatic In the traumatic variety the artery alone may be the seat of the aneurysm or the artery and its satellite vein may be involved in the process

No matter what the type, all of these aneurysms give rise to practically the same symptoms They tend to present as a pulsatile mass in the lateral pharyngeal wall and require some kind of radical vascular surgery for their cure

The prognosis after operation is good If these patients are left, however, to the beneficent mercies of nature, death will ensue sooner or later Thus, in Winslow's collected series of 1926, 70 per cent of the patients operated upon since 1900 were cured, whereas, only 10 per cent of the patients not operated upon recovered Peculiarly enough, all of the latter patients, two in number, were under the care of one man—Caster<sup>10</sup>

We realize thoroughly that the percentage of recoveries is, in all probability, too high, for one is prone to report successes and to forget failures Withal, when these figures are pitted the one against the other, there can be no question of the manifold advantages of operation over a *laissez faire* policy

#### CASE REPORTS

**Case 1**—A colored man, age 38, married, was admitted to the University Hospital November 6, 1932, with a pulsating lump in the left side of the neck He had been shot with a bullet August 12, 1932 The ball entered the back of the neck an inch to the left of the midline on a level with the lobe of the ear to emerge one and one-half inches below the mandible and an inch to the left of the midline The swelling,

which developed immediately, subsided for a time but at the end of two weeks began to increase slowly in size and to ache

Examination revealed a slightly compressible tumor which expanded and beat in unison with the heart. The swelling harbored an audible murmur and a palpable thrill. The bruit and the fremitus lasted throughout systole and diastole but were more pronounced during systole. The lump was oval in shape and the size of an orange. It filled the left submaxillary triangle and encroached upon the superior carotid and posterior cervical triangles. There was no swelling in the tonsillar region. Pulse 78, respirations 20, temperature 98.3° F, blood pressure 120/70. The physical examination was negative with the exception of a penile sore for which the patient had received antiluetic treatment. The aneurysmal nature of the lump was evident, but the exact vessel involved was in doubt. It was thought that the lesion was most probably an arteriovenous fistula between the external or the internal carotid artery and a neighboring vein.



FIG. 1.—(Case 2) Drawing showing the appearance of the protruding mass in the tonsillar fossa. (The artist has reversed the position of the tumor.)

On November 9, 1932, under avertin and supplementary ether anesthesia, an incision was made along the anterior border of the left sternocleidomastoid muscle. The common carotid artery was exposed and dissected free up to its bifurcation. In doing this, it was necessary to ligate the facial vein and the superior thyroid artery and vein. After considerable difficulty, the external carotid artery, which was densely adherent to the aneurysm, was isolated and ligated just beyond the bulb of the primitive carotid. This maneuver did not stop pulsation in the sac. The internal jugular vein was accordingly exposed but was not found to be dilated, which fact ruled out a communication with the artery. To arrest the circulation in the aneurysm, the common carotid artery had to be ligated also. The postoperative course was uneventful. At no time did any cerebral complications develop. The patient was discharged from the hospital December

5, 1932, as cured. The pulsation, thrill, murmur and expansion in the swelling had ceased, and the mass had diminished to one-half of its original volume.

Unlike most extracranial aneurysms of the internal carotid artery this one did not produce a bulging in the throat, but caused a swelling in the neck.

**Case 2**—The patient, a white male, age 27, married, was admitted to the University Hospital May 2, 1936, with a mass in the left side of the pharynx which had been diagnosed as an extracranial aneurysm of the internal carotid artery. The lump was discovered by his physician during a routine physical examination two months before. In April, the patient noticed that the swelling was increasing in size. His tonsils had been removed when he was seven years of age.

Inspection revealed a pulsating mass in the left tonsillar fossa. The tumor was the size of a robin's egg and protruded inward (Fig 1). No bulging was seen in the neck. The swelling expanded in all directions. Pulsation in the mass stopped on compression of the corresponding common carotid artery against the vertebral column to begin anew with the release of the pressure. The physical findings were otherwise of no moment. The Kolmer test was negative on two occasions, as were also the routine laboratory examinations. In the absence of any discoverable cause, the aneurysm was considered of spontaneous origin.

On May 12, 1936, under gas and ether anesthesia, a linear incision was made along the anterior margin of the left sternocleidomastoid muscle. The carotid sheath was opened and the common, external and internal carotid arteries were exposed. The external carotid was displaced laterally and two silk ligatures were placed around the internal carotid just above the bifurcation. The ligatures were not tied until traction upon them had clearly demonstrated cessation of pulsation in the sac.

The postoperative course was smooth and the patient was discharged from the hospital June 2, 1936, as cured. The swelling had shrunk considerably and did not pulsate. The operation caused no cerebral disturbances.

**COMMENT**—This study is based on 18 cases of extracranial aneurysms of the internal carotid artery, of which 16 were culled from the current literature and the two observations herewith presented (Table I). Six of these aneurysms were spontaneous in origin, two, traumatic, nine, erosive, and one was of the arteriovenous type. Extracranial aneurysm of the internal carotid artery occurs in about an equal ratio between the male and the female sexes. In this series, nine of the patients were males and eight were females. In the remaining case the sex was not noted. The right side was affected nine times and the left side nine times. Of the 18 patients, ten, or 55.56 per cent, were cured, two, or 11.11 per cent, showed no improvement, and six, or 33.33 per cent, died. Aneurysm in this situation is a disease of youth. Of the series, 15, or 83.33 per cent, were under 40 years of age. The youngest patient was 11 months old and the oldest 61 years. The cases were distributed in decades as follows: Three in the first, four in the second, three in the third, five in the fourth, one in the sixth, and one in the seventh. One case was described as that of a woman. Some type of radical vascular surgery was performed on 12 patients, with ten, or 83.33 per cent, recoveries, and two, or 16.67 per cent, deaths (Table II). Conservative treatment was practiced on six patients. Two, or 33.33 per cent, of these patients were unimproved and four, or 66.67 per cent, died (Table III).



# ANEURYSM OF INTERNAL CAROTID ARTERY

TABLE I  
SUMMARY OF THE 18 CASES HEREWITH REPORTED UPON

Type	Cured	Unimproved	Died	Total Cases
Spontaneous	5 (83 33%)	1 (16 67%)	0	6
Erosive	3 (33 33%)	0	6 (66 67%)	9
Traumatic	1 (50 0%)	1 (50 0%)	0	2
Arteriovenous	1 (100 0%)	0	0	1
Total cases	10 (55 56%)	2 (11 11%)	6 (33 33%)	18

TABLE II  
SUMMARY OF THE 12 CASES OPERATED UPON

Type	Cured	Unimproved	Died	Total Cases
Spontaneous	5 (100 0%)	0	0	5
Erosive	3 (60 0%)	0	2 (40 0%)	5
Traumatic	1 (100 0%)	0	0	1
Arteriovenous	1 (100 0%)	0	0	1
Total cases	10 (83 33%)	0	2 (16 67%)	12

TABLE III  
SUMMARY OF THE SIX CASES TREATED CONSERVATIVELY

Type	Cured	Unimproved	Died	Total Cases
Spontaneous	0	1 (100 0%)	0	1
Erosive	0	0	4 (100 0%)	4
Traumatic	0	1 (100 0%)	0	1
Arteriovenous	0	0	0	0
Total cases	0	2 (33 33%)	4 (66 66%)	6

The diagnosis should offer no great difficulty if one bears in mind the possible occurrence of the lesion. On occasion, however, it may mimic a tonsillar abscess. Under such circumstances, extreme care must be exercised to avoid a wrong diagnosis. The prognosis is good in those cases subjected to operation, but the outlook is bad for those conservatively treated.

or left to the beneficent influences of nature. Nonoperative treatment has proved worthless. In this small series, 66.66 per cent of the patients so treated died. Of the others, one refused to be operated upon and left the hospital against advice. She could not be located at the time of Robert's report. In the second case, Tonnies believed an embolus had been washed off the sac and had lodged in the anterior cerebral artery. Since the aneurysm itself was inaccessible to operative attack, the only alternative treatment was ligation of the internal carotid artery. Tonnies rejected the latter procedure because of the possibility of increasing the cerebral damage. The diagnosis in this case was made by arteriography. The report did not mention either a pharyngeal or a cervical swelling as being present. The patient was a paralytic. The operation of choice is ligation of the internal carotid artery. The following ligations were performed in this series:

Ligation of the internal carotid artery	3
Ligation of the internal carotid artery, common carotid, internal jugular vein, lingual and facial veins	1
Ligation of the common carotid artery and internal jugular vein	2
Ligation of the common carotid, sac incised and packed	1
Ligation of the common carotid artery	1
Ligation of the common carotid artery by strangulation	1
Ligation of the common carotid artery by fascial strips	1
Ligation of the common carotid, external carotid, superior thyroid arteries and facial and superior thyroid veins	1
Ligation of the common carotid, external carotid, superior thyroid, lingual and facial arteries and sac opened and packed	1

Conservative therapy has nothing to offer in the way of cure and should be tabooed. Those who employ it court disaster. The story unfolded in the reports is a narrative of sad catastrophes. Six cases in this series were treated conservatively without a single cure. Two died of spontaneous rupture of the sac into the mouth, one of an uncontrollable hemorrhage from an incision into the sac, and one of an ulcerative endocarditis. Two of the patients left the hospital with the lesion in the same condition as when they entered.

It is true that Castex<sup>10</sup> reports the cure of two patients by nonoperative measures. In both of these cases, the patients had syphilis. Castex cured these aneurysms by antiluetic medication and local applications. No other reported cases were benefited in the least by such treatment. In view of the high mortality rate attached to conservatively treated cases, some form of radical arterial surgery must remain our sheet anchor in the future as in the past, in spite of the gratifying results obtained by Castex.

The cases of Tollet and Oitmann are grim reminders that death ever threatens from spontaneous rupture of the sac into the mouth, when appropriate surgical measures are withheld.

The nonoperative methods of treatment employed in this series were as follows:

Supposed abscess incised, no pus, only blood escaped	I
No treatment (1) Ligation rejected on account of possibility of increasing cerebral damage	I
(2) Patient had ulcerative endocarditis	I
Compression of common carotid artery	I
Spontaneous hemorrhage, in hospital from January 12 to February 10, could not inspect throat because jaws were locked	I
Patient would not permit a ligation of the carotid	I

#### CONCLUSIONS

(1) Extracranial aneurysm of the internal carotid artery is not a common condition, but it occurs often enough to be borne in mind when one is dealing with unilateral faucial swellings

(2) It is not so much the rarity of the affection that commands attention as its propensity to imitate peritonsillar abscess, which habit of mimicry has, on occasion, led to its being lanced, with fatal results. Therefore, it is much the better policy to look, feel and listen before cutting a bizarre unilateral swelling of the throat than to bemoan at leisure a hasty act

(3) Spontaneous cure may occur, but the usual termination in untreated cases is death from rupture of the sac into the patient's mouth

(4) Ligation of the internal carotid artery is the treatment of choice. If this is impossible, then occlusion of the common carotid artery together with ligation of the external carotid artery between its origin and its first branch should be practiced. If the external trunk be tied distal to a branch, the branch must be ligated also. This provision forestalls the possibility of a reestablishment of the circulation through the internal carotid artery

(5) The majority of patients afflicted with the lesion should recover, if the aneurysm be promptly recognized and properly treated, but the mortality rate will be high under blundering, dilatory, or pernicious tactics. After ligation, the prognosis is good both as regards operative recovery and permanent cure

(6) Aneurysm in other situations is far more prevalent in the male than in the female, in the internal carotid artery it occurs in almost an equal ratio in the two sexes, being slightly more prevalent in the male if all types are considered, but more frequent in the female in the spontaneous variety

Those interested in a further study of the subject may consult the appended tables. Therein are tabulated the essential features of the 18 cases composing this series (Table IV). For the sake of completeness we have summarized in Table V ten additional cases in which the descriptive matter accompanying them does not offer sufficient evidence to warrant a positive statement as to their actual character. All have a distinct bearing, however, on the question of extracranial aneurysm of the internal carotid artery and merit notice. In order to conserve space, we present them in a supplementary table labeled "Doubtful Cases" (Table V)

TABLE IV  
SUMMARY OF THE CASE HISTORIES OF THE 18 PATIENTS COMPOSING THIS SERIES

Case	Author	Sex Age Side	Type Duration	Operation or Treatment Date	Cured	Died	Remarks
1	Henle in Lebram P <sup>1</sup>	F 9 R	Erosive 1 week	Ligation right common carotid artery and internal jugular vein, later because it was wounded dur- ing operation Dec 2 1902	Yes		Admitted Dec 1 1902 with fever of 14 days duration For 3 days bleeding from mouth nose and right ear In right side of neck below jaw was a nonfluctuating tender lump Soft palate was bulged on right side by a tumor with indistinct fluctuation Swelling reached across midline Incision liberated coagulated blood mixed with pus Night of Dec 2/3 patient bled freely from mouth Paralysis of left side developed after operation Discharged Jan 3 1903 with swelling much smaller
2	Stumpf H <sup>2</sup>	F 5 R	Erosive 1 week	Ligation right common carotid artery Oct 18 1915 Religation common carotid strongly pulsating jugular vein also tied		Yes	Sick 14 days with painful swelling in neck and for 4 days a bloody discharge from right ear Oct 15 1915 lump was seen behind ascending ramus of jaw bone In right side of throat was a resistant swelling Tonsil bulged inward Oct 18 free bleeding occurred from right ear and from nose Oct 25 hemorrhage recurred from ear nose and mouth Patient died 5 minutes after second interven- tion Autopsy dilated and spindle shaped right internal carotid artery near its entrance into carotid canal Artery had eroded into cavity of an abscess
3	Reid M <sup>3</sup>	F 61 R	Spontaneous 1 year	Oct 25 1915 Ligation right internal carotid artery Sept 2 1919	Yes		White woman married admitted Aug 27 1919 for extra-cranial aneurysm of internal carotid artery No history of lues and nega- tive Wassermann test Trouble began with tickling sensation in throat Later a swelling resembling a peritonsillar abscess protruded into fauces Eight weeks before admission an incision had been made into swelling Mass was pulsatile and involved soft palate and tonsil It did not show externally For 8 days patient had postoperative right hemicranium At no time was there any sign of paralysis May 29 1922 patient felt a little fullness in throat which however did not pulsate
4	Blair V P in Brown <sup>4</sup>	F 36 L	Spontaneous 7 years	Ligation left common and exter- nal carotids superior thyroid lingual and facial arteries, swell- ing opened and packed with gauze June 1926	Yes		Swelling appeared under angle of jaw in 1919 It was round smooth, 5x4 cm pulsatile and harbored a bruit Tongue was pushed to right side by swelling Patient complained of dysphagia, had had 3 apoplectic seizures, was married, and had 2 children who were living and well Wassermann test was negative In Dec 1926 the woman appeared to be cured She was at that time 4 months pregnant

5	Screer, A <sup>5</sup>	F 22 L	Erosive 2 weeks	Ligation left common carotid artery blood continuing to escape from wound, aneurysmal sac picked with gauze, bleeding then ceased, local anesthesia	Yes	Admitted Nov 24, 1927 with angina of 5 weeks duration Left side of neck abscessed and was incised Dray before admission—15 days after incision of abscess—patient vomited clotted blood Beneath angle of jaw was lump size of man's fist Patient repeatedly spat blood On third postoperative day hemiplegia developed Patient died 4 weeks after operation Autopsy abscess in left hemisphere site of erosion in internal carotid artery not found macroscopically, only on section Screer called it a spurious aneurysm False aneurysm consecutive to a tonsillar abscess
6	Thornval <sup>6</sup>	M 19 L	Erosive	Ligation common carotid artery	Yes	Illness began June 10 1929 with angina followed by peritonsillar abscess which was incised, June 19 Following dry free hemorrhage ensued which ceased spontaneously Six weeks after onset of illness patient returned with pain in neck For past 4 days he had had dysphagia and tinnitus in right ear Inspection of pharynx revealed protrusion above and lateral to tonsil Palpation of swelling disclosed pulsation and on puncture the syringe withdrew arterial blood Diagnosis evident Discharged 4 days postoperatively In a few weeks, pharyngeal swelling had disappeared No signs of lues Nov 12 1929 cure maintained itself
7	Tollet, W <sup>7</sup>	M 18 R	Erosive 1 month	Sept 2 1928 Ligation right internal carotid artery Aug 9 1929	Yes	White man admitted Feb 4 1930 with lump in neck It appeared in Aug 1929 had slowly increased in size but had caused no discomfort Questionable history of chancre in 1918 Had not received luteic treatment Two inches below lobe of ear was pear-shaped mass, of ovoid form, with poles in line of sternomastoid muscle and expansile pulsation Wassermann reaction Feb 8, doubtfully negative, recheck, Feb 14 negative Diagnosis Aneurysm of internal carotid artery Operation revealed a sacular aneurysm June 30 1930 patient in best of health but 2 weeks before swelling somewhat smaller than hen's egg had appeared in right side of neck Mass animated by expansile pulsation Diagnosis Aneurysm of right internal carotid artery
8	Mensing E H <sup>8</sup> and Regan, J R <sup>8</sup>	M 36 L	Spontaneous 1 year	Ligation left common carotid artery by gradual strangulation Mar 6 to Mar 15 1930	Yes	Mulatto woman admitted with diagnosis of peritonsillar abscess For 2 years had noticed a throbbing lump in neck just below ear Night before admission she spat blood She could scarcely open her mouth swallowed with difficulty and spoke in a whisper Left tonsil pushed well beyond uvula, soft palate swollen and red While preparations were being made to open supposed abscess aneurysm discovered Patient left hospital much improved
9	Campbell J L <sup>9</sup>	F Adult L	Spontaneous 2 years	Partial occlusion with an autogenous fascial band 1933	Yes	

TABLE IV (Continued)

Case	Author	Sex Age Side	Type Duration	Operation or Treatment Date	Cured	Died	Remarks
10	Terry T L and Mysel P 10	M 38 R	Arteriovenous	Ten days after injection of thorium wound was reopened under general anesthesia and whirling pools and eddies of arterial blood were seen in internal jugular vein, jugular and lingual veins ligated, facial vein tied at time of injection of thorium Tissues about internal carotid artery for 1½ inches above bifurcation were boggy To prevent back-wash from external carotid common trunk ligated and internal branch tied beyond infiltrated area	Yes		Three weeks after onset of pain in right temporal region patient noticed a swishing sound in right ear, also vertical diplopia which soon disappeared Noise became so intense as to prevent work Hit on head with a 20 years before and 2 months ago struck in temple by piece of timber Examination slight exophthalmos and pulsation of right eye latter synchronous with radial pulse, superficial veins more prominent in right side of neck, loud shrill musical murmur continuous but greatly accentuated during systole heard over right eye in temple and neck Compression of carotid stopped bruit but had no effect on exophthalmos Conjunctival vessels of right eye increased in size and tortuous fundal veins moderately dilated and more tortuous than normal, retinal arteries normal in size and distribution no retinal hemorrhages or edema Roentgenogram of skull showed no increased density in orbit or fracture Wassermann test negative Symptoms were against aneurysm being in or just behind orbit To determine its exact location, internal carotid exposed and 25 cc of thorium dioxide solution injected into it Roentgenograms during and after injection showed a triangular shadow with base near site of injection and apex just below jugular bulb None of thorium entered skull Findings proved that a fistula existed between internal carotid and internal jugular in upper part of neck Day after operation pulsation of eyeball tinnitus headache and bruit had disappeared No postoperative cerebral complications developed Five months after operation exophthalmos was still present Authors thought aneurysm of spontaneous origin and not due to old or to more recent cranial injury As far as they could ascertain this is the only reported case of pulsating exophthalmos caused by an arteriovenous aneurysm in the neck
11	Shipley A M, Winslow N and Walker, W W 11	M 38 L	Traumatic 3 months	Ligation left common carotid superior thyroid external carotid arteries and facial and superior thyroid veins, avertin anesthesia supplemented by ether	Yes		Neuro admitted Nov 6 1932 with aneurysm of left internal carotid artery caused by bullet wound received on Aug 12 1932 Swelling developed immediately but subsided for a time At end of two weeks lump began to increase slowly in size and to ache The slightly compressible tumor expanded and beat in unison with heart and had an audible murmur and a palpable thrill Tremitus and

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bruit lasted throughout systole and diastole but were more prominent during systole. Swelling was egg-shaped oval size of an orange. It filled left submandibular triangle and encroached upon superior carotid and posterior cervical triangles. Gave history of penile sore for which he had received antiluetic treatment. Mass pointed in neck and unlike most aneurysms in this situation did not produce a bulging in tonsillar region. Discharged Dec 5 1932 as cured. Pulsation thrill murmur and expansion in swelling had ceased and mass had diminished to two-thirds its original volume. At no time did any cerebral symptoms develop.

White man married admitted May 2 1936 with an expansile pulsating mass size of a robin's egg in left side of pharynx. No bulging seen in neck. Pulsation stopped on compression of common carotid artery. Kolmer test negative on 2 occasions. Operation caused no cerebral disturbances.

Illness began Jan 25 1915 with angina. Feb 2 left-sided peritonsillar abscess developed. Admitted Feb 3. Left tonsil and uvula pushed to right swollen and red. On incision no pus escaped. Only blood. During night of Feb 4 patient spat blood. Incision wound yielded blood. Cavity picked. Tampon removed Feb 6. That night active hemorrhage began and child died before any treatment could be given. Autopsy. Erosive aneurysm of left internal carotid artery size of pea in cavity of peritonsillar abscess. Exploding shell in 1918 caused multiple wounds among them one in neck. After recovery patient well until July 1932 when he experienced fleeting weakness in right arm. In Feb 1933 oculist consulted for failing vision in left eye. Mar 29 1933 had another attack of paralysis in right arm along with loss of speech. Both quickly subsided. Sept 19 1933 paralysis recurred and he felt severe pain in head. Ventriculography revealed nothing abnormal so Tönness decided to perform arteriography. Sept 29 1933 local anesthesia left common carotid artery isolated at its bifurcation and 6 cc of thorotrast injected into lumen of internal branch. Roentgen ray films showed aneurysm size of bean on internal carotid artery in front of and a finger's breadth to left of first and second cervical vertebrae. Ramifications of internal carotid visible but trunk of anterior cerebral could not be identified. In this region were many fine threadlike vessels. Paralysis attributed to embolus having been washed from sac to lodge in anterior cerebral artery. Since aneurysm was inaccessible to operative attack the only alternative treatment was ligation of internal carotid artery. Latter procedure rejected because of fear of increasing cerebral damage.

12	Shiple, A. M., Winslow N. and Walker W. W. Jr.	M 27 L	Spontaneous 2 months	Ligation left internal carotid artery May 12 1936	Yes	Yes
13	Stumpf, H. H.	M 13 L	Erosive 2 weeks 1915	None		
14	Tönness W. H.	M 36 L	Traumatic 1 1/2 years 1918	None	Same	

TABLE IV (Continued)

Case	Author	Sex Age Side	Type Duration	Operation or Treatment Date	Cured	Died	Remarks
15	Tollet W	11 mos R	Erosive 1 month	None 1926		Yes	Unconscious infant admitted Dec 30 1926 with blood escaping from right ear and throat filled with coagula. Although bleeding ceased on compression of carotid and tamponade of ear and pharynx child died in a few minutes. Mother had noticed on Dec 25 swelling beneath child's ear. Dec 29 bloody discharge began to flow from ear. A doctor on attempting to remove clot from auditory canal started up a violent hemorrhage which soon ceased. In night bleeding recurred to stop spontaneously. On repetition of hemorrhage next day child was brought to hospital. Autopsy. Marked bulging at upper part of right lateral pharyngeal wall with no detectable perforation, internal carotid artery thickened for 5 mm of its length to a point 1 cm below its entrance into carotid canal. In median wall of involved area was a hole 1 Mm in diameter. Clotlet opened into plum sized cavity filled with clots. Wall of cavity was composed of a few millimeters thick membrane. At lower part of sac was a pea sized hole which opened into eustachian tube near its pharyngeal end. No pus found. Sections of carotid at level of carotid foramen showed normal walls but in neighborhood of rupture adventitia and tunica media thickened by inflammatory products. Sac composed of connective tissue with areas of cellular infiltration—chiefly polymorphonuclear leucocytes. No part of arterial wall was seen in capsule. Case of pseudo aneurysm caused by erosion of internal carotid artery.
16	Bullrich R A, y Besimsky, M 16	M 26 R	Erosive 1½ months	None 1927		Yes	Patient with ulcerative and vegetative endocarditis developed aneurysm of internal carotid near bifurcation of common carotid artery. Man died July 31 1927 or 1½ months after onset of symptoms. Autopsy. Fusiform aneurysm of internal carotid artery.
17	Ortmann, K K 17	F 19 L	Erosive	None 1929		Yes	Perforation of internal carotid artery consecutive to cervical phlegmon with formation of false aneurysm in pharyngeal space and spontaneous rupture into nasopharynx resulting in fatal hemorrhage. Admitted Jan 12 1929 died Feb 10 1929. She bled repeatedly from nose. Fauces could not be satisfactorily inspected because mouth was locked. Swelling in neck. Feb 5 developed a right-sided hemiplegia. Autopsy was performed.



White female married, multipara, seen in Apr 1930 with swelling in throat which had been gradually getting larger for 18 months. At times woman felt throbbing in lump but never any pain. On looking into throat one saw a rounded mass which filled whole right tonsillar area. Pulsation felt in tumor and a blowing sound heard with stethoscope placed on lump. Externally nothing was seen felt or heard. Repeated and provocative Wassermann tests as well as roentgenologic examinations were negative. Pulse 114, blood pressure 184/94. Before ligation of common carotid artery could be performed patient left hospital against advice and at time of report could not be located.

Same

Spontaneous  
1 1/2 years  
None  
1930

F  
53  
R

18     Roberts, A. D.<sup>15</sup>

TABLE V  
SUMMARY OF THE CASE HISTORIES OF THE TEN PATIENTS IN WHOM THE TYPE OF THE ANEURYSM WAS CONSIDERED DOUBTFUL

Author	Sex Age Side	Type Duration	Operation or Treatment Date	Cured	Died	Remarks
DeWar D <sup>1</sup>	F 27 R		Ligation common carotid artery June 2 1859	Yes		Admitted Apr 8 1859 with swellings about angle of jaw and lump in situation of tonsil which was supposed to be an abscess External masses disappeared but internal tumor continued to increase in size On 3 occasions profuse hemorrhages took place from it Distinct pulsation felt in lesion Seven months after ligation aneurysm had disappeared
Lefort in Lefort R et Piquet J <sup>2</sup>	M 52 L		Penarterial sympathectomy encirclement of vessel with strip of fascia, ligation and division thyro-linguo facial trunk dilatation involved 3 carotids but especially bulb Oct 14 1925	Yes		In Aug 1925 patient consulted Piquet for dysphagia Examination dilatation in carotid bulb On palpation a vertical elongated violently pulsating tender ovoid mass size of nut felt Bulgings and beats visible to sight Patient also perceived them and was incommode by them Mass was reducible on compression It had not the appearance of an arteriovenous fistula because it had no thrill at most a slight systolic fremitus Wassermann test on 2 occasions negative Summary One witnessed the development of a dilatation on the carotid bulb of rapid growth In Apr 1926 patient well circulation normal and dilatation had diminished
Lefort in Lefort R et Piquet J <sup>3</sup>	F 57 L	2 months	Ligation and division thyro-linguo facial trunk, carotids were dilated but dilatation involved mostly internal carotid artery, penarterial sympathectomy aponeurotic graft slid behind bulb of carotid and its margins sutured together in front of artery	Yes		Patient noticed a small pulsatile tumor in mid-carotid region This was a small arterial dilatation at level of carotid bulb It formed a vertically elongated mass conserving the general form of the vessels It was unmarked by beats, reducible on compression which procedure produced uneasiness No evidence of lues Wassermann test negative In Feb 1920 pulsation in carotid artery visible but expansion not abnormal Mass scarcely more voluminous than opposite artery
Duval A <sup>4</sup>	M Man L	Arteriovenous	Dec 12 1927 Compression direct and digital pressure on common carotid artery 1862	Improved		Cut behind ear with knife Admitted to hospital 8 hours afterwards with swelling in neck which harbored both bruit and thrill Compression applied to carotid stopped murmur and fremitus In first 10 days 4 hemorrhages occurred These were arrested by direct compression upon tumor and digital pressure on common carotid Noise in tumor sometimes interfered with sleep Feb 15 1864 bruit was less intense Admitted May 11 1866 for angina Next day child found in syncope with blood flowing freely from nose and mouth Examination Pulsat-
Franklin M M <sup>5</sup>		Dissective	Bleeding stopped by sponge pulled into and lodged in vault of pharynx	Yes		

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growing tumor in neck. Inspection of mouth disclosed blood gushing from a point posterior to tonsillar pillar. Hemiplegia of right side with aphasia. Swelling in neck slowly disappeared. Nasal plug removed in 3 days. Year later child had recovered speech and suffered only from slight disability of right arm and talipes equinovarus. According to Stump this was an aneurysm of internal carotid artery. Data are too scanty to warrant its acceptance though it might possibly have been one in spite of its spontaneous disappearance.

Admitted Jan 7 1903 Cervical nodes swollen Blood and pus were  
escaping from right ear Right soft palate swollen but not pulsating  
Right side of neck incised but no pus found Swelling in soft palate  
increased in size and encroached upon right half of throat Jan 12  
1903 swelling incised for tonsillar abscess with escape of blood  
Compression at site of cut and on carotid had no effect Child died  
in 2 minutes

appeared he felt a systolic souffle synchronous with cardiac beats. After convalescence was resumed he occupied and was not bothered by without inconvenience. He saw normally and was not bothered by his fremitus until 1926 when a severe fatigue was followed by cephalgia and nonpulsatile exophthalmos of right eye. In Aug. 1931 symptoms had not abated. Examination At site of wound thrill but no expansion. Similar fremitus felt in pharynx behind posterior pillar which pulsed synchronously with pulse. In parotid region continuous bruit heard. Pressure on common carotid artery stopped souffle and thrill. Cardiovascular system not affected. Diagnosis Arteriovenous aneurysm of right internal carotid artery and internal jugular vein. As the condition had been stationary for 4 years authors decided to ligate only in case of aggravation of symptoms.

Seen Apr 5, 1927 for dysphagia Fusiform aneurysm of internal carotid artery seen with laryngeal mirror Author did not tie vessel because of patient's age the probable condition of the fellow vessel which might not give an adequate supply of blood to brain and the fact that patient had had condition for a long time and was fairly comfortable Neither H Thomas nor A Wythe thought swelling to be an aneurysm but probably an ectasia

White male seen Mar 6 1933 for blowing noise in ear Noise began in Feb 1928 He had just recovered from otitis media on right side Left side of neck swollen Palpation revealed no abnormal pulsation but on auscultation, a blowing hissing sound was heard It extended from below tip of mastoid process to top of left side of head Blood pressure 180/90 Heart normal If collateral circulation improved, author intended to tie carotid artery

ter  
by string attached to nasal catheter

1896

Yes

Zone

Erosive  
2 weeks

MI 2 R

Lehrstuhl für  
Statistik

1903

Improved	Injection of 25 cc gelatin sub-cutaneously
Improved	Improved

1926

MI  
oldin  
R

Worms G et  
German?

Improved

Arteriovenous  
11 years

None

2 years

IV

Barney F. B. 3

1927

Some

None

NI 54

McIntyre D R 4

8301

54

TABLE V (Continued)

Author	Sex Age Side	Type Duration	Operation or Treatment Date	Cured	Died	Remarks
Markowicz H <sup>10</sup>	M 65 R	7 weeks	None 1933	Same		Lues at 21 Seven weeks before pulsation in right side of head was so perceptible as to awaken him when sleeping Blood Wassermann test positive 2 weeks before Mar 28 1933 pulsations in both sides of neck and temples were very prominent Had a slight Romberg Tonsil Posterior arch of palate and pharyngeal wall on right side pulsated actively Posterior rhinoscopy revealed bluish-gray protrusion shimmering through mucous membrane on right side between nose and opening of eustachian tube It was as broad as a finger and 2 cm long Its walls seemed extraordinarily thin If vessels of neck were compressed pulsation in swelling decreased Blood pressure 120 Author thought lesion was either a tortuosity of internal carotid just before it entered carotid canal or an aneurysm of the vessel He inclined to latter view because of luetic history

BIBLIOGRAPHY OF THE REPORTERS OF THE 18 PATIENTS COMPOSING THIS SERIES

- <sup>1</sup> Lebram, P Ueber Arrosion der Carotis bei peritonsillaren Abszessen Ztschr f Ohrenheilk, Wiesbaden, 51, 1-30 (Case 1, pp 2-4), 1905-1906
- <sup>2</sup> Stumpf, H Ueber Arrosionen der Arteria carotis bei Halsabszessen Ztschr f Laryngol, Rhinol u ihre Grenzgeb, Leipzig, 9, 383-394 (Case 2, p 386), 1919-1920
- <sup>3</sup> Reid, M Aneurysms in the Johns Hopkins Hospital Arch Surg, Chicago, 12, 1-74 (Case 55), 1926
- <sup>4</sup> Blair, V P In Brown Aneurism of the Internal Carotid ANNALS OF SURGERY, 85, 635, 1927
- <sup>5</sup> Særker, A Ueber Arrosionblutungen nach Peritonsillarabszessen Monatschr f Ohrenheilk u Laryngo-Rhinol, Berlin, 62, 648-688 (case reported on p 649), 1928, also in Ortmann, K K Et Tilfælde af dødelig Blødning ved Arrosion af Arteria carotis interna Hospitalstidende, København, 73, 95-105 (see p 100), 1930
- <sup>6</sup> Thornval Tilf af Aneurisma spurium Art carotis efter prationsillaer Phlegmone Hospitalstidende, København, 72 (see appendix, Dansk otolaryngol Selskab's Forhandlingar, 1928-1929, pp 41-45), 1929, also in Ortmann, K K Hospitalstidende, 73, 95-105 (see p 95), 1930
- <sup>7</sup> Tollet, W Två Fall av Aneurisma spurium Beroende på Arrosion av Carotis interna Finska lakaresallskapet's Handlingar, Helsingfors, 72, 305-314 (Case 2), 1930
- <sup>8</sup> Mensing, E H, and Regan, J R Aneurysm—Operative Cure of Left Internal Carotid by "Slow Ligation" Method, with Subsequent Development of Aneurysm of Right Internal Carotid Artery Wisconsin Med Jour, Madison, 29, 702-704 (case on p 703), 1930
- <sup>9</sup> Campbell, J L Diagnosis and Treatment of Aneurism Jour Med Assn of Georgia, Atlanta, 12, 319-323 (case reported in last paragraph p 320), 1933, also reprint of same, 1933, 2nd paragraph, p 3
- <sup>10</sup> Terry, T L, and Mysel, P Pulsating Exophthalmos Due to Internal Carotid-Jugular Aneurysm J A M A, Chicago, 103, 1036-1040 (obs on pp 1037-1038), 1934
- <sup>11</sup> Shipley, A M, Winslow, N, and Walker, W W Aneurysm in the Cervical Portion of the Internal Carotid Artery Report of Two New Cases ANNALS OF SURGERY, 105, No 5, May, 1937
- <sup>12</sup> Shipley, A M, Winslow, N, and Walker, W W *Idem*
- <sup>13</sup> Stumpf, H Ueber Arrosionen der Arteria carotis bei Halsabszessen Ztschr f Laryngol, Rhinol u ihre Grenzgeb, Leipzig, 9, 383-394 (Case 1, p 385), 1919-1920
- <sup>14</sup> Tonnis, W Traumatisches Aneurysma der linken Art carotis int mit Embolie der linken Art cerebri ant und retinae (Traumatic Aneurysm of Left Internal Carotid Artery with Embolism of Anterior Cerebral Artery and Retinal Arteries, Use of Arteriography of Internal Carotid), Zentrabl f Chir, Leipzig, 61, 844-848, 1934
- <sup>15</sup> Tollet, W Två Fall av Aneurisma spurium Beroende på Arrosion av Carotis interna Finska lakaresallskapet's Handlingar, Helsingfors, 72, 305-314 (Case 1), 1930
- <sup>16</sup> Bullrich, R A, y Besinsky, M A proposito de un caso de aneurisma de la carotida interna Revista de la Asoc Med Argentina, Buenos Aires, 43, 5, 1930, also Aneurysm of the Internal Carotid Artery of Infectious Origin, abstr, J A M A, Chicago, 94, 2030, 1930
- <sup>17</sup> Ortmann, K K Et Tilfælde af dødelig Blødning ved Arrosion af Arteria carotis interna Hospitalstidende, København, 73, 95-105 (case on pp 95-98), 1930, also Fatal Hemorrhage Following Erosion of Internal Carotid Artery, abstr, J A M A, Chicago, 94, 2034, 1930
- <sup>18</sup> Roberts, A D Extracranial Aneurysm of the Internal Carotid—Report of a Case Ann Otol, Rhinol and Laryngol, St Louis, 40, 77-81, 1931

## BIBLIOGRAPHY OF THE REPORTERS OF THE TEN "DOUBTFUL CASES" ANALYZED IN TABLE V

- <sup>1</sup> DeWar Pulsating Tumor in the Right Tonsil, Hemorrhages, Ligature of Common Carotid Artery, Recovery London Med Times and Gaz, 1, 90 (Case 49), 1860
- <sup>2</sup> Lefort in LeFort, R, et Piquet, J Ectasie du bulbe carotidien, troubles sympathiques, sympathectomie carotidien, engainement du carrefour carotidien par un greffon aponevrotique libre, guérison Bull et mem de la Soc Nationale de chir, Paris, 53, 232, 1927
- <sup>3</sup> LeFort in Lefort, R, et Piquet, J Ectasie de la carotide interne traite par l'engainement aponevrotique Bull et mem de la Soc Nationale de chir, Paris, 55, 451, 1929
- <sup>4</sup> Duval Hopital de Brest—Histoire Succincte de la Salle de Clinique Chirurgicale, etc Arch de med Navale, Paris, 1, 397-417 (obs 34, p 413, Aneurysme variqueux de la carotide interne), 1864, also in Stimson, L A Arterio-venous Aneurysm of the Common Carotid and Internal Jugular Vein, etc American Jour Med Sc, Phila, n s, 87, 325-337 (abst of case on p 330), 1884
- <sup>5</sup> Franklin, M M Retropharyngeal Abscess Ulcerating into Left Internal Carotid Artery (?) Followed by Right-sided Hemiplegia with Aphasia and Recovery Medical News, N Y, 72, 237, 1898
- <sup>6</sup> Lebram, P Ueber Arrosion der Carotis bei peritonsillaren Abszessen Ztschr f Ohrenheilk, Wiesbaden, 51, 1 (Case 2), 1905-1906
- <sup>7</sup> Worms, G, et Germain Exophthalmie non pulsatile due a un aneurysme carotido-jugulaire interne d'origine traumatique Bull Soc d'ophthal de Paris, 43, 761, 1931
- <sup>8</sup> Barnes, E B Aneurism of the Internal Carotid Proceedings Royal Soc Med, Lond, 20, 1778, Pt 2, 1926-1927
- <sup>9</sup> McIntyre, D R Arterio-venous Aneurism (Fistula of the Left Internal Carotid Artery and Jugular Vein J A M A, Chicago, 101, 278, 1933, also New Orleans Med and Surg Jour, 86, 559, 1934
- <sup>10</sup> Markowicz, H Ein Fall von Aneurysma (?) der Arteria carotis interna am Rachendache (A Case of Aneurysm of Internal Carotid Artery at Roof of Pharynx) Monatschr f Ohrenheilk und Laryngo-Rhinol, Wien, 67, 415, 1933

## GENERAL BIBLIOGRAPHY

- <sup>1</sup> Agnew, D H Trans Amer Surg Assn, 4, 252, 1886, and Principles and Practice of Surgery, by D H Agnew, Philadelphia, J B Lippincott & Co, 1, 591, 1878
- <sup>2</sup> Bartlett in Heaton Birmingham Med Rev, 30, 304, 1891
- <sup>3</sup> Beck Monatschr f Ohrenh u Laryngo-Rhinol, 52, 606, 1918
- <sup>4</sup> Bergmann, E von System of Practical Surgery, by E von Bergmann, etc, translated by W T Bull, New York and Philadelphia, Lea Brothers & Co, 2, 70, 1904
- <sup>5</sup> Bobbio Il polichinico, Roma, sez chir, 13, 50, 1906
- <sup>6</sup> Booth Phila Med Jour, 6, 1002, 1900
- <sup>7</sup> Bruns in Blauel Beitr z klin Chir, 39, 620, 1903
- <sup>8</sup> Callander, C L A Study of Arterio-venous Fistula, etc, Johns Hopkins Hosp Repts, 19, 259, 1920
- <sup>9</sup> Cannuyt Arch Franco-Belges de chir, 25, 404, 1921-1922
- <sup>10</sup> Castex Contrib a l'etude des aneurysmes de la carotide interne Ann de med, Paris, 16, 138, 1924
- <sup>11</sup> Chartier Anev art-venieux de la carotide et de la jug int gauche La Caducee, Paris, 15, 128, 1915 (Callander classified it as internal carotid but vessel involved was primitive)
- <sup>12</sup> Chassaignac Bull Soc de chir de Paris, 10, 83, 1859
- <sup>13</sup> Coomes Med Herald, 7, 503, 1885
- <sup>14</sup> Cooper, Sir A Lectures of Boston, Lilly and Wait, 2, 62, 1831
- <sup>15</sup> Cooper, B In discussion of J P Vincent's paper (Vessel involved not specified)

- <sup>16</sup> Crile, G DaCosta's Modern Surg, Philadelphia, W B Saunders Company, 8th edit, p 551, 1919
- <sup>17</sup> DaCosta Modern Surgery, by J C DaCosta, Philadelphia, W B Saunders Company, 8th edit, p 551, 1919
- <sup>18</sup> Dubrueil D'un cas d'aneur de la carotide int, *etc* Gaz méd de Paris, 6th s, 54, 373, 1883, also in Muratet, A These de Montpellier, 1883
- <sup>19</sup> Duke Dublin Med Press, 19, 65, 1848
- <sup>20</sup> Edmunds Trans Path Soc London, 43, 42, 1891
- <sup>21</sup> Fehleisen Ein Fall v Aneur d Carotis communis Deutschr Ztschr f Chir, Leipzig, 14, 1, 1880-1881
- <sup>22</sup> Franceschetti, A La Sindrome dell'aneur d carotide interna Rev oto-neuro-optal, Bologna, 9, 482, 1932 (Intracranial)
- <sup>23</sup> Friedrich, G Traum sackformiges Aneur d rechten u linken art Carotis interna nach alter Oberkieferresektion Zntbl f Chir, 61, 1586, 1934 (Intracranial)
- <sup>24</sup> Gallo, A G, y Spota, B B Paralisis radicular total de plexo braquial con sindromo de Claudio Bernard-Horner por herida de bala, aneur art-venoso jugulo-carotideo, *etc* Prensa méd Argent, 17, 604, 1930 (Aneur involved primitive carotid and internal jugular, no operation had been done at the time of the report)
- <sup>25</sup> Giraldes Bull Soc de chir de Paris, 5, 70, 1854, also in Bull de la Soc Anat, 29, 298, 1854
- <sup>26</sup> Godfray Med Times and Gaz, London, 12, 409, 1882
- <sup>27</sup> Gross, S D System of Surgery, by S D Gross, Philadelphia H C Lea's Son and Co, 6th edit, 1, 749, 1882
- <sup>28</sup> Helferich in Werner Deutsch Ztschr f Chir, 67, 592, 1902
- <sup>29</sup> Helman Yezhemes Ushn, Gorlov i Nosov Boliezn, 6, 75, 1911, also Medycynai kromka lakarska, 44, 681, 1909
- <sup>30</sup> Hirsch Monatschr f Ohrenh, 48, 780, 1914
- <sup>31</sup> Hohl in Burrows In discussion of J P Vincent's paper (Vessel not specified)
- <sup>32</sup> Horsley, J S Surgery of the Blood-Vessels, by J S Horsley, St Louis, C V Mosby Company, 1915, p 238
- <sup>33</sup> Hulbert St Louis Courier Med, 16, 265, 1886
- <sup>34</sup> Jianu Rev de chir, Bucuresti, 13, 596, 1909
- <sup>35</sup> Johnson Trans Amer Laryngol, Rhinol, and Otol Soc, 7, 226, 1901, and Am Jour Med Sci, Philadelphia, 122, 273, 1901
- <sup>36</sup> Johnson, A B Operative Therapeutics, by A B Johnson, New York, D Appleton and Company, 1, 387, 1915
- <sup>37</sup> Jordan ANNALS OF SURGERY, Philadelphia, 46, 931, 1907
- <sup>38</sup> Joret Gaz méd de Paris, 8, 457, 1840
- <sup>39</sup> Lee in Fenger and Lee Gaillard's Med Jour, 35, 10, 1882
- <sup>40</sup> LeFort Bull de l'Acad de méd, Paris, 3 s, 78, 108, 1907
- <sup>41</sup> Liston Lancet, London, 1, 864, 1842
- <sup>42</sup> Lubbers, K Ueber lebensgefährliche u todliche Blutungen a d Art carotis bei Halsabszessen Ztschr f Ohrenheilk u d Krankh d Luftwege, Wiesbaden, 66, 18, 1912 (Case 1—Bleeding from mouth, source not determined, Case 2—Patient spat blood, autopsy showed erosion of superior laryngeal artery, article contains 12 other examples of bleeding from carotid system)
- <sup>43</sup> Lyot et Petit Gaz méd de Paris, 1, 159, 1897
- <sup>44</sup> Marschik in Klarfeld Wien klin Wchnschr, 28, 1361, 1915
- <sup>45</sup> Matas, R Keen's Surgery, Philadelphia, W B Saunders Company, 5, 321, 1911
- <sup>46</sup> McMullen and Stanton ANNALS OF SURGERY, Philadelphia, 51, 76, 1910
- <sup>47</sup> Minch Pest med-chir Presse, 38, 765, 1901
- <sup>48</sup> Morestin Bull et mem Soc clin de Paris, n s, 41, 2443, 1915
- <sup>49</sup> Moser Inaug-Diss, Univ of Strassburg, 1911, p 11
- <sup>50</sup> Neuffer Ztschr f Wundarzte u Geburtsh, 4, 206, 1852
- <sup>51</sup> Pattarin, P La legatura dell'art carotide interna nel suo ultimo tratto di corso extra-

- craneo, a monte di un possibile aneur immediatamente sottostante al forame carotico Gazz med Lomb, 88, 147, 1929 (Article contains no case report)
- <sup>62</sup> Perier Recueil de mem de med et de chir et de pharm Mil, 2nd s, 14, 311, 1854
- <sup>63</sup> Perthes in Keppler Inaug-Diss, Univ of Leipzig, 1910
- <sup>64</sup> Pircher Wien med Wchnschr, 12, 553, 1862
- <sup>65</sup> Polak Weekblad Nederl Tijdschr, 36, 1213 (Pt 1), 1900
- <sup>66</sup> Porter Dublin Hosp Repts, 5, 208, 1830, also Dublin Jour Med Sc, 17, 83, 1840
- <sup>67</sup> Prewitt Trans Amer Surg, Assn, 4, 233, 1886
- <sup>68</sup> Quenu, E A propos de dix-huit anev traum operes par Pierre Duval Bull et mem de la Soc de chir de Paris, 41, 584 (Pt 1), 1915 (Callander classifies lesion as aneurysm of internal carotid but in reality the aneurysm was between the primitive carotid and internal jugular vein)
- <sup>69</sup> Schlagenhauser Zentrabl f allg Path u path Anat, 29, 423, 1918-1919
- <sup>70</sup> Shipley, A M, and Lynn, F S Carotid Tumors J A M A, Chicago, 66, 1602, 1916 Winslow, N, and Walker, W W ANNALS OF SURGERY, 105, No 5, May, 1937
- <sup>71</sup> Syme Lond and Edinburgh Jour Med Sc, 2, 961, 1842
- <sup>72</sup> Texier Bull med Paris, 21, 593, 1907
- <sup>73</sup> Vander Veer Trans Amer Surg Assn, 4, 252, 1886
- <sup>74</sup> Vas Jahrb f Kinderh, 83, 493, 1916
- <sup>75</sup> Velebil Casop lek Cesk, Prague, 52, 975, 1913
- <sup>76</sup> Vincent, J P Two Cases of Disease of the Brain Following the Application of a Ligature to the Carotid Artery Lancet, London, 1, 134, 1846, also Trans Royal Med and Chir Soc of London, w s, 29, 2nd s, 11, 37 (Case 1), 1846 (Vessel not specified)
- <sup>77</sup> Wagner in Keppler Inaug-Diss, Univ of Leipzig, 1910, p 14
- <sup>78</sup> Winslow, N Extracranial Aneurysm of the Internal Carotid Artery Arch Surg, Chicago, 13, 689, 1926, also ANNALS OF SURGERY, Philadelphia, 75, 688, 1922
- <sup>79</sup> Wulff Munch med Wchnschr, 47, 687, 1900
- <sup>80</sup> Zamboni in del Fabro 13th Cong int de med, Paris, sect chir gen, 10, 516, 1900

DISCUSSION —DR RUDOLPH MATAS (New Orleans, La) —I always look forward to Doctor Winslow's papers with a keen anticipation of the profit and pleasure I expect to derive from them For a number of years he has given us the benefit of his patient and painstaking bibliographic researches on the history and statistics of some of the rarer aneurysms of the carotid tract, of which his study of those of the extracranial carotid, in 1925, and of the temporal artery in last year's Transactions are notable examples This year, in association with Doctor Shipley, he has brought to us a complement to his previous studies on the extracranial internal carotid which covers his experience during the intervening years and completes to date a monograph which will endure in the literature as the most complete record of the surgery of this relatively rare and particularly dangerous type of carotid aneurysm

On previous occasions I have referred to the merit of Doctor Winslow's work, which is not that of the mere compiler of the statistics of others, but of the one who seeks at their sources the authentic facts upon which to base his conclusions This is an ungrateful task because few appreciate the time and labor involved in these researches except those who delve in the depths of the work and obtain pleasure from their findings It is unfortunate, also, that the more differentiated a specialty is, the less likely it is to interest the general workers who are only concerned with the conclusions Sometimes, those of us who labor in this special field, *ie*, vascular surgery, in our enthusiasm imagine that everyone is as much interested in our work as we are, only to discover that we are simply boring our colleagues with the details of our enterprises None the less, though the problems of vascular surgery are highly specialized, there is no practicing surgeon who can avoid or afford to ignore them



In connection with Doctors Winslow and Shipley's survey, I am glad to contribute a brief statistical synopsis of my personal experiences in the surgery of the internal carotid aneurysms which has not yet been published and which, I trust, may serve as an appendix to his record

STATISTICAL SYNOPSIS OF DOCTOR MATAS' PERSONAL EXPERIENCES IN THE SURGERY OF  
INTERNAL CAROTID ANEURYSMS

1888-1936

Total carotid ligations for aneurysms	81
Five deaths, mortality 6.6 per cent	
Total operations for aneurysms of the internal carotid tract, including 12 arteriovenous (pulsating exophthalmos)	18
One death, mortality 5.5 per cent	
Total operations for aneurysms of the extracranial internal carotid	5
Ratio of extracranial to intracranial aneurysms (5 : 18) or 27 per cent extracranial	
Ratio of extracranial to total (308) aneurysms treated by Doctor Matas, including 254 operated cases (5 : 308) or 1.6 per cent	
Ligations or aluminum bands applied directly to the internal carotid	6
One death, mortality 16.6 per cent	

The fatal case was that of F. S., colored male, age 42, who had a pathologic (luetic) aneurysm of the left common carotid at its bifurcation. A band was applied to the *internal* carotid, on its distal side, between the aneurysm and the skull, April 22, 1922. Cerebral symptoms developed 18 hours after the occlusion. The band was removed and circulation in the internal carotid restored. The patient, however, died, April 24, 1922, in coma, 48 hours after the occlusion. Autopsy revealed extensive thrombosis in left middle cerebral artery. The circle of Willis was markedly arteriomatous and showed miliary dilatations. The artery at the seat of constriction by the band showed no pathologic change.

In addition to the six ligations of the internal carotid for extracranial lesions, there was one case (Miss I.) of internal carotid aneurysm treated by a band on the *common* carotid with perfect recovery.

In seven lesions of the internal carotid, four followed tonsillectomy, or 57.14 per cent caused by tonsillectomy or tonsillar infections.

In addition to the seven extracranial lesions of the internal carotid, there were 12 cases of pulsating exophthalmos, in six of which the common carotid was ligated, with no fatalities. Ligations for arteriovenous aneurysms of the carotid tract, including the internal, are relatively free from cerebral complications.

REMARKS—(1) My experience, like Doctor Winslow's, confirms the classic belief that the ligation of the *internal* carotid is more liable to fatal cerebral disturbances than the ligation of the *common* carotid, as the former excludes the reversed (collateral) flow through the external carotid.

(2) Cerebral disturbances after the ligation of the internal carotid are essentially caused by cerebral ischemia which may be due to a number of factors, notably, thrombosis in the circle of Willis, but not embolism, as the normal flow in the artery is reversed after the ligation *to* and not *from* the ligature.

DR. NATHAN WINSLOW (closing)—It is remarkable that these cases come to the general surgeon rather than to the nose and throat men. Of our four cases, three were operated upon by Doctor Shipley and one by myself. My patient was a Negress and a Negro doctor had attempted to plunge a lance into the supposed abscess, fortunately he did not succeed in his purpose, and the woman sought my advice.

# FURTHER OBSERVATIONS ON THYROID DISEASE IN A NONENDEMIC AREA

AN ANALYSIS OF SIX HUNDRED SIXTY-TWO SURGICAL CASES AND SIXTEEN  
NONSURGICAL DEATHS

URBAN MAES, M D , FREDERICK F BOYCE, B S , M D , AND ELIZABETH M  
McFETRIDGE, M A

NEW ORLEANS, LA

FROM THE DEPARTMENT OF SURGERY OF THE SCHOOL OF MEDICINE OF LOUISIANA STATE UNIVERSITY AND THE  
RECORDS OF CHARITY HOSPITAL IN NEW ORLEANS

IN 1933,<sup>1</sup> and again in 1934,<sup>2</sup> we reported a series of 341 surgical cases of thyroid disease treated in Charity Hospital in New Orleans between January 1, 1927, and April 1, 1934. Herewith, we are adding to our first reports 321 surgical cases of thyroid disease treated in the same institution from the latter date to July 1, 1936 (Table I). This gives us a total of 662 cases of thyroid disease for a period of nine and one-half years in a region in which goiter is not only nonendemic but also relatively and absolutely infrequent. We make that statement deliberately, with full knowledge of the recent reports by the United States Public Health Service<sup>3, 4</sup> to the effect that in certain areas of Louisiana the incidence of goiter is as high as it is anywhere in the world. For that matter, surgeons of this community have long been aware of these isolated endemic areas. Their existence, however, does not alter the fact that even when they are given their full value, the incidence of thyroid disease in this part of the world is still very low. That is proved by the fact that it required a period of nine and one-half years to collect 662 surgical cases of this disease from an institution which, during that same period, had admissions of approximately 456,000, almost one-half of which were surgical.

TABLE I

INCIDENCE AND MORTALITY OF THYROID DISEASE IN CHARITY HOSPITAL  
IN NEW ORLEANS FROM JANUARY 1, 1927, TO JULY 1, 1936

First Series	341 cases	26 deaths	7.6 per cent
Second Series	321 cases	12 deaths	3.7 per cent
Combined Series	662 cases	38 deaths	5.7 per cent

Certain comments which we made in our previous communications ought to be repeated at this time. Now, as then, we must begin with an apology for reporting so small a series, in the face of the thousands of cases reported from true goiter centers elsewhere. But the very infrequency of thyroid disease in this community is both our explanation and our justification. Very few reports from the South have been made. Jones's<sup>5</sup> and Clifton's<sup>6</sup> series from Atlanta, Harris's<sup>7</sup> from Shreveport, Street's<sup>8</sup> from Vicksburg, about complete the list. Mahorner's<sup>9</sup> and Cohn's<sup>10</sup> cases from New Orleans are included in our own comprehensive series, which is, we believe, the largest number of cases so far put on record from a nonendemic area. All of these reports go

to prove the point we made in our previous communications, that any pathologic state is most a problem where it is least a problem. Furthermore, our achievements in thyroid disease furnish us no cause for pride, and they are not likely to be materially bettered until we bring the facts into the open and study them from the dual standpoint of what we have done and what we have left undone.

We pointed out in our first papers that as a consequence of the infrequency of thyroid disease in this community, no surgeon can have a very extensive experience with it. In the first series, the 341 operations were performed by 37 surgeons. In the second series, the 321 operations were performed by almost the same number, 38, though not always by the same surgeons. Combining the two series, we find that the 662 operations were performed by 54 surgeons, a state of affairs which clearly prevents any single man from operating upon a very large number of cases, and which forces all of us to gain our experience almost literally by the trial and error method. It follows, too, that with such a limited number of cases, it is almost impossible to train interns, anesthetists and nurses in the proper conception of thyroid disease or to make them realize the deadly potentialities of the toxic variety.

We emphasized another very serious consideration in our earlier papers, the practical impossibility, under the circumstances prevailing in Charity Hospital, of properly preparing hyperthyroid patients for operation. The complacent and entirely correct pronouncement of a recent writer, that a ward bed for an hyperthyroid patient is naturally out of the question, falls strangely upon the ears of those who are accustomed to include in their orders for such cases the underlined instruction "Do not put anybody else in bed with this patient." All wards are overcrowded, the colored more so than the white—a serious consideration, in view of the higher mortality apparently inherent in thyroid disease in that race—and the absolute quiet which is the basic desideratum of preoperative preparation simply cannot be attained. We might add that the situation will be, if anything, worse while the new hospital is in process of construction. At least one case, not included in the series we are reporting, has already shown us the tragic consequences of the unavoidable noise and confusion incident to that project.

We noted in our former communications certain other facts. The chaotic nomenclature of thyroid disease, which all too frequently seemed to arise from an underlying confusion of thought concerning it, the unwise and inconsistent use of Lugol's solution, the tendency among both interns and staff to ascribe toxic manifestations to all varieties of thyroid disease, toxic and nontoxic alike, the abnormally high basal metabolic rates, which we attributed to the unpropitious circumstances under which these tests must be taken, circumstances which, we fear, are likely to be even worse in the immediate future than they were then, because of the cramped quarters and general confusion associated with the present hospital construction. These and other matters we discussed, and we pointed out the inevitable end-result, a mortality several

times higher than the mortality of thyroid surgery in endemic areas, even in the hands of the average surgeon, and very many times higher than the mortality of such surgery in the hands of an expert

We begin our new discussion with the statement that, just as in the first series we reported, we have taken the liberty, in a fair number of cases, of reclassifying these patients according to a study of their records. That is by no means, of course, equivalent to a study of the patients themselves, but it still permits a detachment of outlook which seemed sadly lacking in many of the records we studied. Most important of our changes was the removal of patients from the toxic to the nontoxic group, an apparent impertinence in which we believe we were fully justified. We have commented before on the tendency of the historians to paint in all cases the picture of toxic disease, and the tendency of the staff to accept such a history without question for purposes of diagnosis and treatment. Lord Horde<sup>11</sup> has recently and properly called attention to the madness that seizes us all when the word thyrotoxicosis is bandied about, and it is quite evident that such a warning is needed, and should be heeded, in our surgical community. In the first place, the fact that a Negro has "pop eyes" does not constitute grounds for assuming, without further evidence, that he has exophthalmic goiter. Persons brought up in the South know, even though in these circumstances they seem to forget it, that protuberant eyes are frequently seen in Negroes, and a simple question as to the duration of the supposed exophthalmos would promptly eliminate the diagnosis, for it would show that the supposed pathologic state had been present almost since birth. In the second place, ignorant or neurotic patients, and particularly Negroes, are notoriously prone to exaggerate their "miseries" and to furnish any symptoms expected of them. The historian who begins to secure the anamnesis with the textbook picture of Graves' disease in his consciousness is very likely to emerge from the endeavor with the same picture on the chart. As for the basal metabolic rate, the time has long since passed when a single high reading, or even repeated high readings, are regarded as of independent value in diagnosis. In other words, it takes more than a combination of nervousness and an enlarged thyroid, even with the further evidence of a high basal metabolic rate, to justify the diagnosis of toxic thyroid disease. Let us quote a case in point.

**Case Report**—A Negro woman, age 40, presented herself with the story of a growth in her neck which she had first noted ten years previously, immediately after her fourth pregnancy. It had remained stationary until four months before admission, since which time it had grown very rapidly. An unusually level headed intern noted on the chart that the patient had no symptoms of any sort, toxic, nervous, cardiac or mechanical, she simply desired the growth removed because its presence was disfiguring and because the recent rapid increase in size had frightened her. Her temperature, pulse and respiration were always within normal limits. Following subtotal thyroidectomy, without special preparation, she made an entirely uneventful recovery and was out of the hospital on the sixth postoperative day. Merely on the basis, so far as we could determine, of one basal metabolic rate reading of plus 35 and another of plus 23, a staff man was less wise than his intern and labeled the case as a toxic nodular goiter.

Such cases we have taken the liberty of reclassifying. We did not feel at liberty to drop from the series certain cases of supposed thyroid disease in which we doubted whether the symptoms complained of had anything to do with the thyroid. One such patient, for instance, operated upon two years ago with the diagnosis of diffuse toxic goiter, had as her chief complaint a constantly sore throat. She is in the hospital at the present time, not in the least benefited by her thyroidectomy, and still complaining of her sore throat, for which the nose and throat staff, who probably should have been consulted originally, have advised tonsillectomy. We reclassified such cases, even though we did not take the liberty of eliminating them.

Another small group of patients seem to have been submitted to surgery on the basis of "first catch your thyroid." They came into the clinic or the hospital for other conditions, usually recurrent appendicitis or gynecologic states, and then enlarged and symptomless thyroids were observed and promptly removed. The tendency was particularly notable and is particularly to be regretted, as we shall point out later, in young Negro girls. These young girls very frequently exhibit enlarged necks, and their goiters, if they really exist, we believe are better treated by other measures. In spite of careful study of the records and a serious endeavor at proper classification, we are still confronted with a certain proportion of cases which are either incorrectly classified as toxic, or which are really not thyroid disease at all. As a result, the inclusion of the latter group has altered for the better our general mortality for thyroid disease, while the inclusion of nontoxic cases in the toxic group has had the same effect on our mortality for the toxic disease. In short, and to speak quite bluntly, we believe that because of such errors our thyroid mortality is apparently lower than it actually is.

The results of our reclassification are shown in Table II. Why the death rate in Charity Hospital should reverse the usual situation elsewhere and be higher for the toxic diffuse than for the toxic nodular variety, we cannot say. The figures for the toxic variety are gratifying, in view of our comment in our first paper upon the marked increase in the incidence of this type of thyroid disease in the course of the period studied. It rose from ten cases, with no deaths, in 1927, to 31 cases with five deaths, in 1933. In the second period, even though, as we have just pointed out, we cannot accept our figures unreservedly, there is no doubt that both the incidence and the mortality have fallen. Even such uncompromising realists as ourselves must grant, too, that a general mortality of 3.7 per cent for the second period studied is decidedly better than a general mortality of 7.6 per cent for the first period studied, and we gladly admit that we can find valid explanations for at least part of the decrease.

First of all, the mortality fell because our preoperative preparation was far more intelligent in the second series than it was in the first. Even with our limited and utterly unsuitable facilities, we do try to keep our patients quiet, in beds by themselves, screened off from the rest of the ward, separated from the other patients and separated also from the well intentioned but ill advised

TABLE II

DISTRIBUTION OF THYROID DISEASE IN CHARITY HOSPITAL,  
NEW ORLEANS

## Diffuse Nontoxic

First Series	87 cases	6 deaths	8.0 per cent
Second Series	101 cases	1 death	0.99 per cent
Combined Series	188 cases	7 deaths	3.7 per cent

## Diffuse Toxic

First Series	94 cases	13 deaths	13.8 per cent
Second Series	61 cases	4 deaths	6.5 per cent
Combined Series	155 cases	17 deaths	10.9 per cent

## Nodular Nontoxic

First Series	77 cases	1 death	1.3 per cent
Second Series	99 cases	3 deaths	3.0 per cent
Combined Series	176 cases	4 deaths	2.3 per cent

## Nodular Toxic

First Series	83 cases	6 deaths	7.2 per cent
Second Series	60 cases	4 deaths	6.7 per cent
Combined Series	143 cases	10 deaths	7.0 per cent

## Total Nontoxic Cases

First Series	164 cases	7 deaths	4.2 per cent
Second Series	200 cases	4 deaths	2.0 per cent
Combined Series	364 cases	11 deaths	3.0 per cent

## Total Toxic Cases

First Series	177 cases	19 deaths	10.8 per cent
Second Series	121 cases	8 deaths	6.6 per cent
Combined Series	298 cases	27 deaths	9.1 per cent

attentions of their relatives and friends. The difficulty of isolating a friendly Negro, however ill he may be, can be appreciated only by those who have made the attempt. We feed these patients on high carbohydrate diets, a matter which the cooperation of the diet kitchen has completely simplified. We give them fluids freely, and we resort to preoperative infusions of glucose whenever there is any indication for such therapy.

One thing we are refraining from, which was responsible for a certain number of deaths in our early series, is the performance of miscellaneous, nonemergency procedures on toxic patients. The extraction of teeth before operation, for instance, undoubtedly was at least partially responsible for death in two of the four cases in which it was done, as were similar apparently trifling procedures in three other cases. Bayley,<sup>12</sup> in an excellent study of thyroid crisis, has pointed out the unwisdom of employing at certain times even such immediately applicable diagnostic measures as basal metabolic rate studies or roentgenologic examinations, and our experience, limited though it be, amply corroborates his statement.

We are using Lugol's solution more wisely than we once did. In the second series as in the first it was still occasionally used in the type of case in

which it is most positively not indicated, that is, the diffuse and the nontoxic nodular varieties, but such errors were increasingly infrequent. It was still used, as it was in the first series, for absurdly long or absurdly short periods of time, from one to 90 days, to make an honest confession. But as a rule the administration covered a period between nine and 15 days, a more or less reasonable limit in view of what histologic studies have shown concerning its effect on the thyroid tissue.

Lugol's solution is still, unfortunately, being used for long periods of time as a therapeutic measure, before the patient is turned over to the surgeon. That is not the surgeon's fault, of course, though it in no wise lessens his anxiety and responsibility when the patient finally reaches him, entirely refractory to iodine and deprived of its benefits in immediate preoperative therapy. Sometimes, of course, the circumstances are beyond anybody's control. When the patient takes iodine on the advice of her friends, or on the basis of her own perverted and imperfect knowledge, or out of a mail order catalogue—as actually happened twice in this combined series—certainly nobody in the medical profession can be held responsible.

Our chief complaint against the use of Lugol's solution in this second series is that almost never was it begun with the definite idea that operation would be performed within a certain period of time. Sometimes it was begun before the patient's consent to surgery was secured, and she refused operation for days or weeks or even months after she had been definitely prepared for it. More than once iodine was ordered as soon as the patient entered the ward, even before the differentiation into toxic or nontoxic goiter had been made or before the case had been worked up at all. Lahey's<sup>13</sup> insistence that the surgical risk be evaluated when the patient is first seen, before any diagnostic measures have been employed or any treatment instituted, is an admonition all of us might well take to heart. We do not sufficiently realize that all iodine remissions are temporary remissions and that the use of this drug is indicated only for the control of an actual or impending crisis or as part of the preparation for a definitely planned operation. Here, as elsewhere, conditions in thyroid surgery have been enormously improved by its use, but there is frequently a casual and almost frivolous use of this agent which entirely destroys its effect and which we cannot too strongly condemn.

Our anesthesia is far more intelligent than it was. Ethylene is now the anesthetic of choice. Ether is still occasionally used, but in this second series avertin was not used at all, nor was local. The latter anesthesia, we believe, is contraindicated in a clinic in which the experience with thyroid disease is not very large—if indeed it ever should be used. The lightest and safest and most controllable type of anesthesia, if we may so express it, is necessary in patients with thyroid disease, and particularly in Negro patients, who are likely to furnish many respiratory problems. Adequate exposure is frequently difficult and tedious, in women as well as in men, because of the highly developed musculature of the neck, due to their performance of heavy work and then habit of carrying baskets of clothes, vegetables, moss and other heavy

objects on their head. In the Negro, again, because of delay and neglect the glands are likely to be large and adherent, they are frequently substernal, and compression and distortion of the trachea lead to respiratory difficulties of the gravest sort, both at operation and later, and in all types of disease. Most of our deaths from respiratory collapse occurred in Negroes with large, nodular glands.

Our postoperative treatment is far wiser than it was. The liberal use of opiates as long as the need for them exists is now almost routine. Restlessness is not permitted to develop. Lugol's solution is very frequently given after operation, the idea on our own service being to spare the patient the strain of its abrupt withdrawal. We have tided several patients over threatened crises by this particular measure.

Our sheet anchor in postoperative treatment is the use of glucose infusions. We use them in all cases in which operation has caused any degree of shock or hemorrhage, regardless of the type of the disease. We use them, indeed, almost routinely on our own service, and rarely on any service is the former practice followed of giving fluid by vein only when the need for it arises. Deaths from crisis have therefore decreased, convalescence is smoother, and the patients are discharged within a shorter time. Of the value of this method of therapy there can be no possible doubt.

There were 12 stage operations in the second series against only eight in the first, both ligation and lobectomy being included in this term. Undoubtedly the divided operation was a very wise precaution in many cases. In many other cases, however, it seemed to us that it was done without justification, on patients who were not toxic or only mildly toxic, and for no apparent reason other than to prove the rather obvious thesis that less surgery is always safer than more surgery. Of course its use under such circumstances proves nothing at all, and the economic rights of both patient and hospital are lost sight of in this trivial employment of a really valuable measure. Even stage surgery carries a risk in bad cases, there were six fatalities in the 20 cases in which it was employed. This is particularly true of ligation, which terminated fatally in two of the five cases in which it was done. We are more and more inclined to agree with Pemberton, that if the patient does not respond to proper iodine therapy, he is not likely to be saved by ligation. More than one Negro male has proved that point to us.

Drainage, we might interpolate here, is still not a matter of standardized practice on any service. We ourselves approve of it. We believe that it has no appreciable effect on the scar if it is done at the angles of the incision, and we believe also that it is a definite protection against hemorrhage, in that it reveals it immediately, and against infection. We were interested to note, in support of our position, that perhaps three-quarters of all cases in which hematmata formed, or in which convalescence was delayed by infections or by serous discharges from the wound, were cases in which drainage had been omitted.

We think we may fairly say, too, that in this second series we have much



less reason to reproach ourselves for deaths from hemorrhage, from shock and from technical errors than we formerly had. Our technic may be still imperfect but it is considerably better than it was. Pneumonia is a less frequent and less fatal complication because of more careful preoperative observation, a wiser choice of anesthesia, and the postoperative use of the oxygen tent and of inhalations of  $\text{CO}_2$  as may be indicated.

One final point may be mentioned, that in the second series there was almost routine examination of the vocal cords before operation. This is as much a protection for the surgeon as for the patient. Even more care than usual is demanded in operating upon a patient one of whose vocal cords is already damaged, and if such damage is evident after operation, it is well for the surgeon to know whether it is his responsibility or whether it already existed. The precaution was omitted in a recent case on our own service, and when unilateral paralysis of the cord was discovered after operation, the surgeon was not a happy man until he discovered, from an overlooked clinic sheet, that his carelessness had been provided for there and that a luetic infiltration and not his poor technic was responsible for the trouble.

Thyroid disease in the Negro is so special a problem that it deserves some extended comment. The once general belief that toxic goiter did not occur in that race has long since been exploded. L. H. Heilmann,<sup>14</sup> in 1931, reported 40 cases from Lakeside Hospital, and advanced the opinion that the Negro is quite as susceptible to toxic thyroid disease as is the white man. We question the fairness of a comparison between the type of Negro he dealt with in the North and the type of Negro with whom we must deal in the South, but we concur in his opinion, and would go farther. We believe that toxic thyroid disease, when it occurs in the Negro in this community, tends to be a severer and graver condition than the same disease in white individuals.

In our first series of 341 cases (Table III) of thyroid disease, 148 cases, just over 43 per cent of the number, occurred in the Negro, and of these, 73, roughly half of the total, were of the toxic variety (Table IV). In the second series of 321 cases, 169, 52.6 per cent, occurred in the Negro, but of these only 50, less than a third, were of the toxic variety. We noted, as we have already pointed out, in the later years of our first study a marked increase of toxic thyroid disease in this community, and especially in the Negro. In the first three years of that study there had been only 14 such cases in the Negro, with no deaths, whereas, in the last four years there had been 59 cases with nine deaths. We speculated whether in the general financial straits in which this county had found itself since 1929, and in the increasing strain of modern life, the Negro might be losing his normal placidity. In the second series that increase seems to have been more or less checked. On the other hand, there is practically no difference in the mortality for the two series, 12.3 per cent in the first (73 cases with nine deaths) and 12 per cent in the second (50 cases with six deaths). That practically stationary mortality must be compared with the mortality in the white toxic group, which has fallen very decidedly. In the first series the mortality was 9.6 per

cent (104 cases with ten deaths), whereas, in the second it has fallen to 28 per cent (71 cases with two deaths)

TABLE III

## RACIAL INCIDENCE AND MORTALITY OF THYROID DISEASE

## First Series

White	193 cases	11 deaths	5.7 per cent
Negro	148 cases	15 deaths	10.1 per cent

## Second Series

White	152 cases	3 deaths	2.0 per cent
Negro	169 cases	9 deaths	5.3 per cent

TABLE IV

## RACIAL INCIDENCE AND MORTALITY OF TOXIC THYROID DISEASE

## First Series

White	104 cases	10 deaths	9.6 per cent
Negro	73 cases	9 deaths	12.3 per cent

## Second Series

White	71 cases	2 deaths	2.8 per cent
Negro	50 cases	6 deaths	12.0 per cent

## Combined Series

White	175 cases	12 deaths	6.9 per cent
Negro	123 cases	15 deaths	12.2 per cent

The general relationship between males and females in our first series was roughly one to 7.5 and the mortality for the whole male group was considerably higher than for the female group (Table V). Even more disturbing was the mortality for Negro males, 25 per cent. Those same tendencies are unfortunately continued in the second series of cases. The relationship is roughly one to eight, approximately the same as in the first group. The total male mortality is still several times higher than the total female mortality, and the Negro male mortality has risen to the appalling figure of 28.6 per cent. The risks of toxic thyroid disease in the male Negro furnish a very serious problem, which we shall consider again in our discussion of non-surgical deaths.

How to explain such discrepancies we do not know. It is usual for the male mortality of thyroid disease to be higher than the female, and the argument has frequently been advanced that there is a direct relationship between the infrequency of the disease in the male and its severity. But why should the general Negro mortality be so much higher than the white mortality (12.2 to 6.9 per cent)? And why should the disease be so highly fatal in the Negro male? It is our impression though we cannot substantiate it statistically, that toxic thyroid disease is rather more frequent and more severe in the paler mulatto women, those with a large admixture of white blood, than in the more pure blooded types. But that does not hold true of

# NONENDEMIC THYROID DISEASE

TABLE V

RACIAL AND SEX INCIDENCE AND MORTALITY OF TOXIC  
THYROID DISEASE

First Series

White Male	20 cases	2 deaths	10.0 per cent
Negro Male	20 cases	5 deaths	25.0 per cent
White Female	173 cases	9 deaths	5.2 per cent
Negro Female	128 cases	10 deaths	7.8 per cent

Second Series

White Male	19 cases	0 deaths	0.0 per cent
Negro Male	14 cases	4 deaths	28.6 per cent
White Female	133 cases	3 deaths	2.3 per cent
Negro Female	155 cases	5 deaths	3.2 per cent

Combined Series

White Male	39 cases	2 deaths	5.1 per cent
Negro Male	34 cases	9 deaths	26.5 per cent
White Female	306 cases	12 deaths	3.9 per cent
Negro Female	283 cases	15 deaths	5.3 per cent
Total Male	73 cases	11 deaths	15.1 per cent
Total Female	598 cases	27 deaths	4.6 per cent

men. The most "impressively toxic" patients we have seen, to use Lahey's vivid phrase, were coal black Negroes. Their color does not necessarily eliminate the possibility of white blood, but there was certainly no visible evidence of it. When we are called upon to treat toxic thyroid disease in coal black Negro males, we can be certain that there are breakers ahead.

The high Negro mortality in thyroid disease can perhaps be partially explained by the general tendency of the race to postpone medical consultation in any disease in which pain is not an outstanding feature. In the nontoxic variety, this delay results in large, adherent, very nodular tumors. In the toxic varieties the chain of events is clear. The patient may have safely weathered a series of mild crises but their cumulative effects are seen in myocardial disease and extreme degrees of hypertension. Cardiovascular complications, quite aside from those of thyroid origin, are more frequent in the Negro than in the white patient, perhaps as the result of syphilis. It is a hospital rule that Wassermann examinations be made on all patients, and the surgeon who violates that rule on a Negro male ward is likely to regret his oversight. Syphilis is astonishingly frequent, and untreated syphilis and toxic thyroid disease do not go well together. It may be, too, that the same tendency prevails in thyroid disease as is evident in other so-called diseases of civilization, that when the native immunity to any pathologic process is lost, its manifestations are likely to be very severe. Our own studies have convinced us of the truth of this theory in peptic ulcer,<sup>15</sup> gallbladder,<sup>16</sup> and appendiceal disease,<sup>17-18</sup> and carcinoma of the stomach,<sup>19</sup> liver<sup>20</sup> and gallbladder.<sup>21</sup> Whatever the reason, there is no doubt that when the Negro does pass into a thyroid crisis, his condition is likely to be very serious. We have personally

seen several cases in which, in spite of the proper therapeutic measures, the patients literally burned themselves up. And yet such crises, our personal experience shows, are actually less frequent and less severe among white patients in this community than they are elsewhere, where thyroid disease is endemic.

We are increasingly impressed with the new, rather generally accepted idea that the four varieties of thyroid disease, diffuse and diffuse toxic, nodular and nodular toxic—we prefer the nomenclature of the American Society for the Study of Goiter—represent not different types of thyroid disease but different degrees of the same basic pathology. On the other hand, we are thoroughly convinced that toxic thyroid disease, at least in this community, arises in a different way in the Negro and the white races. The disease in the white patient arises as virgin pathology, so to speak, in a gland which is not the seat of previous disease. In the Negro, just as is frequently the case in endemic areas, it arises on the basis of a previous nontoxic diffuse goiter. This type of goiter, which is first noted in adolescence, gives rise to no symptoms per se, and in the majority of cases no further pathologic change occurs in it. These Negro women are phlegmatic, they take life as it comes, their emotions are superficial and noisy rather than deep-rooted and essential and there is no special strain upon the organism to fan the gland into activity. It is distinctly unusual, in our experience, to elicit from the Negro woman the history of any emotional strain or other event from which she can date the beginning of her thyroid symptoms.

Whatever be the reason, in the occasional case the inactive gland is fanned into activity and the diffuse toxic stage is reached. The white woman at this point is likely to present herself for treatment. The Negro woman ignores her disease, perhaps because her sensibilities are less keen and her toxic manifestations are therefore less marked. The gland, in its natural cycle, then passes over into the nontoxic stage and whether or not toxic manifestations again appear depends upon whether or not the factors, known or unknown, which were responsible for the original toxicity again become effective. In the occasional case it is quite possible that the gland may return to its original colloid or resting state, by the working of the law that all toxic thyroid disease will eventually burn itself out if it does not first burn out the patient. The fact that the Negro carries her thyroid enlargement longer than the white patient and endures her symptoms longer before she seeks medical aid is to us an explanation of the fact that nodular goiter is proportionately more frequent than the diffuse type in this race. Still further proof is the fact that colloid or diffuse goiter, the final stage of the cycle, was three times as frequent among Negro patients over 40 years of age as among white patients. Both these considerations lead to another point which should be emphasized, that the history of the disease is quite as important in diagnosis as are the immediate symptoms or the physical properties of the gland in one's hand.

The prevalence among young Negro women of enlarged necks, or enlarged thyroid glands, to speak more accurately, we have noted carefully since our

last communication. Then it was only an impression, now we know it to be a fact. Within the last six months we have had half a dozen such patients on our own service, whom we are observing at repeated intervals. We do not advise surgery for them, for the tendency to operate on such patients, as we have already said, we consider very unfortunate. We merely observe carefully the increase or decrease in the size of their necks in relation to the measures we have instituted, and we determine our further course by whether or not symptoms develop. Usually they do not. In the meantime, we cannot regard a symptomless enlargement of the thyroid gland as an indication for thyroidectomy.

In our first communication on this subject we called attention to Lahey's<sup>22</sup> statement that in his experience nonsurgical deaths from thyroid disease have been practically equivalent to postoperative surgical deaths. It was not the situation here, we stated, and it was not then. In the period covered by our first report there were only three medical deaths against 26 surgical deaths. But that situation has changed. During the period covered by our second study there were 13 nonsurgical toxic against 12 surgical toxic deaths. Even more disturbing, eight of those deaths occurred in 1935, in which year there were only two surgical deaths.

Those 16 deaths deserve very careful study. We may begin by saying that they were all toxic thyroid deaths. We discarded some six other fatal cases in which thyroid disease was present but in which it seemed to us to be the background rather than the principal cause of the fatality. Nine cases were of the diffuse and seven of the nodular toxic variety. All the nodular toxic cases occurred in Negroes, which substantiates our theory of the pathologic cycle of thyroid disease in this race. Six patients were white and ten Negroes. Twelve were females, and four, all Negroes, were male, proving again our point that toxic thyroid disease is a very deadly condition in the Negro male. In view of our continuous sunshine all year, and our constant supply of sea food and fresh fruits and vegetables, we are not usually inclined to put much stress on the seasonal incidence of goiter. On the other hand, there may be some significance in the fact—there would be elsewhere, we are sure—that 14 of the 16 deaths occurred between March and October, a period which in this latitude is always warm or very hot.

Most of these patients were admitted in a hopeless state, if not actually moribund. Five of them exhibited a psychosis, two were in coma, four were delirious, one had acidosis and one jaundice. In the patients from whom a history could be obtained (12) there was a story of a loss of weight varying from 40 to 64 pounds. Twelve had cardiac complications of some sort, usually very serious, and two had syphilis. All of the 12 whose histories could be secured had been treated for longer or shorter periods of time by medical measures. Four of them had taken Lugol's solution, and we have no doubt that if adequate questioning had been possible, the number would have been materially increased. The standard treatment for thyroid crisis was employed

in all cases, but these unfortunate individuals were doomed and nothing could be expected to help them

Where the responsibility for these deaths lies is another matter. Most of the patients, as we have said, were admitted too ill for any treatment to be of avail—but surely some responsibility rests upon the internists who treated them medically for months and years without considering, as an alternative, the possibility of surgery. One of these patients died on our own service after transfer to us, while she was being prepared for operation. The preparation, we now realize, was hopelessly inadequate, but we did not comprehend until too late the full seriousness of her condition. We are in no position, therefore, to distribute blame. But these deaths do prove perfectly a point emphasized by Sloan,<sup>23</sup> that the mortality of this condition will never be reduced to the irreducible minimum until both physicians and surgeons realize that this is a constitutional and not a local state, a disease in which surgery is only one step in the cure, a disease in which constant cooperation between surgeons and internists, and not occasional formal consultations, forms the first principle of adequate therapy. These deaths certainly prove that it does not exist in this one.

Lahey<sup>13</sup> has recently said that with increasing experience he is more and more certain that deaths associated with hyperthyroidism are chiefly liver deaths, as is proved by the terminal jaundice sometimes present, the development of hyperpyrexia without infection and even before surgery, and the benefit achieved by the measures commonly used to combat liver damage, chiefly glucose infusions, forced fluids and transfusion. With that view we are in complete accord. Definite autopsy evidence of hepatic damage in thyroid disease has been furnished by a long list of observers and experimenters, including Weller,<sup>24</sup> Keen<sup>25</sup> and Rusk,<sup>26</sup> Hashimoto,<sup>27</sup> Goodpasture,<sup>28</sup> Beaver and Pemberton,<sup>29</sup> and Cameron and Karunaratne,<sup>30</sup> to mention only a few. Our own studies<sup>31-32</sup> on the so-called liver death have furnished additional evidence. The whole situation is well summed up by Moir,<sup>33</sup> in a recent comprehensive review of the liver lesion in thyroid disease. The interrelationship he remarks, can be demonstrated clinically by the occurrence of jaundice physiologically by increasing evidence of altered hepatic function, experimentally by evidence of hepatic dysfunction following the administration of thyroid extract and thyroxin, and morphologically by structural changes of varying degree. The practical application of these facts has been emphasized by Frazier and his associates, Brown, Freeman and North,<sup>34-35-36</sup> who have repeatedly pointed out the importance of intravenous glucose therapy as a prophylaxis against postoperative thyroid crisis and who have furnished convincing statistical proof of their claims. We are in full agreement with their conception that fatty changes in the liver are likely to be just as serious to the patient with hyperthyroid disease as is the simple depletion of the liver glycogen upon which heretofore we have tended to focus our entire attention.

In view of this new conception of thyroid disease, we have been impressed with the necessity of finding some method by which, if we may so express it,

the patient's state can be estimated in terms of the hepatic factor. Such a test would be of particular value in a nonendemic community such as this, where the individual surgeon's experience with thyroid disease is so limited that it is often very difficult for him to evaluate the patient correctly from the standpoint of surgical risk.

In the hippuric acid test of liver function, as devised by Quick<sup>37</sup> for use in hepatic and biliary disease, we believe we have found a method which fulfills these requirements better than any method hitherto available. It is a simple test, which can be easily used by any competent technician. It disturbs the patient as little as any test can. Except that it requires absolute accuracy—and what test should not?—the human equation is entirely eliminated, particularly the reaction of the patient, who always complicates the situation in such an estimate of operative risk as the basal metabolic rate, for instance.

To date, we have used this test in approximately 140 cases of various types of disease, the number including a series of control cases and also including 65 cases of various types of thyroid disease. We are naturally unwilling to go on record statistically until the number of completely studied cases is larger, but we are willing to make certain statements at this time. By means of this test we believe we can say with a fairly high degree of accuracy that one toxic patient is a good surgical risk and another, without very careful preparation, is a bad one. By repeated tests we believe that we can safely say, at the end of the planned preparation, that the patient has become a good risk, or a fair one, or remains a poor one, and must be submitted to operation with the full knowledge that the cards are stacked against a successful outcome. We are able to show by this test that the immediate result of operation, in toxic and nontoxic cases alike, is a prompt and sometimes very sharp decrease in the liver function, more marked, of course, in the former type of disease. We can prophesy that the patients who show a gradual rise of liver function after the first day or two will go on to prompt recovery, while patients who show a progressive decrease in liver function are likely to have a stormy convalescence and perhaps lose their lives. With further experience we hope to be able to determine the lower limit of safety in this test, so that we shall be able to say that some patients, no matter how urgently they may need thyroid surgery, had better be left to do their own dying, since the postoperative drop in liver function would be more than their badly damaged livers could endure.

An emphatic warning must be issued not to read into this test more than it can tell. It interprets liver damage in terms of liver function, repeated tests interpret further alterations in the liver in terms of liver function, but a single test and repeated tests indicate nothing more. Most emphatically, this test does not indicate the type of risk presented by the so-called thyrocardiac patients, in whom the heart condition has probably become more important now than the thyroid state. It is most important to realize that in thyroid disease there eventually comes a time when the visceral damage wrought by the hyperthyroid state actually overshadows the initial hyperthyroidism. That

type of risk this test does not indicate, nor does it indicate the possible risk from respiratory failure and similar postoperative complications. Two recent cases have brought that lesson home to us very clearly. Both patients were Negroes, both exceedingly toxic on admission, both very carefully prepared for operation, both with liver functions, which had been not more than 40 to 50 per cent of normal on admission, restored practically to normal before operation. One patient, a male, died of congestive heart failure 36 hours after his second lobectomy, the other, a woman, of some type of respiratory failure, which could not be determined, three hours after an apparently normal reaction from operation. In neither case was there the smallest evidence of thyroid crisis. The evidence of heart failure in the first case was unmistakable and the cardiac risk had been perfectly comprehended before operation was attempted. The second patient with a normal temperature, blood pressure, pulse and respiration simply stopped breathing. No liver function test or any other sort of test will prevent fatalities of this sort. We do believe, however, that if the hippuric acid test is used with a proper conception of its scope and limitations, it will be of material value in reducing the mortality of toxic thyroid disease so far as that mortality arises from hepatic damage.

#### SUMMARY

(1) To the 341 surgical cases of thyroid disease which we have previously reported from Charity Hospital in New Orleans, we are adding 321 similar cases, the combined series of 662 cases covering a period of nine and one-half years.

(2) The disease is a peculiar problem in this area. Because it is non-endemic, both general and individual experience with it is limited, and this comparative inexperience results, in combination with other factors, in a mortality several times higher than is reported from various goiter centers.

(3) The reclassification of the records was necessary in many instances chiefly because of the tendency to consider nontoxic thyroid disease as toxic.

(4) The increasing incidence of toxic thyroid disease noted in our first communications has apparently been halted and the mortality in the second series is less than half of the mortality in the first series. This decrease we attribute to better preoperative preparation, abstinence from nonemergency preliminary procedures, a wiser use of Lugol's solution, a more intelligent selection of anesthesia, and better postoperative treatment. Particularly important is the frequent use of glucose preoperatively and almost routinely postoperatively.

(5) Thyroid disease presents a very serious problem in the Negro, and particularly in the Negro male, in whom it is highly fatal, though no adequate explanation can be advanced.

(6) The disease arises on a different basis and runs a different course in Negro and in white subjects.

(7) Sixteen nonsurgical thyroid deaths are analyzed, ten of which occurred in Negro patients.



(8) The relationship of the thyroid gland and the liver is briefly discussed, and the hippuric acid test is suggested as an index of liver damage. Its scope and limitations are outlined.

# REFERENCES

- <sup>1</sup> Maes, U, Boyce, F F, and McFetridge, E M. Thyroid Disease in a Nonendemic Area. *Am J Surg*, 24 (ns), 232-253, May, 1934
- <sup>2</sup> Maes, U, Boyce, F F, and McFetridge, E M. Hyperthyroidism in the Negro. *West J Surg Obst and Gynec*, 42, 456-463, August, 1934
- <sup>3</sup> Olesen, Robert. Distribution of Endemic Goiter in the United States as shown by Thyroid Surveys. *Public Health Reports*, 44, 1463-1487, June 21, 1929
- <sup>4</sup> Scott, L C. Quoted by Weston, W. Specially Produced Milk in the Solution of the Goiter Problem. *Southern Med J*, 27, 249-254, March, 1934
- <sup>5</sup> Jones, E G. Goiter in the Southeast. *J A M A*, 71, 712, 1918
- <sup>6</sup> Clifton, B H. Discussion of Mortality following Operation on Thyroid Gland in Atlanta, 1929 to 1933 Inclusive. *J M A Georgia*, 24, 212-217, June, 1935
- <sup>7</sup> Harris, E W. Goiter in the Negro Race, with Report of Cases. *Tri-State M J*, 1, 80, 1929
- <sup>8</sup> Street, A. Hyperthyroidism. *New Orleans M & S J*, 88, 335-339, December, 1935
- <sup>9</sup> Mahorner, H R. Goiter. A Brief History of Its Surgery and a Review of 128 Operated Cases in a "Nongoiter" District. *New Orleans M & S J*, 85, 395, 1932
- <sup>10</sup> Cohn, I. Thyroid Disease in the Negro. *Southern Surg*, 4, 416-421, December, 1935
- <sup>11</sup> Horder, Lord. Thyrotoxicosis. *J A M A*, 107, 279-282, July, 1936
- <sup>12</sup> Bayley, R H. Thyroid Crisis. *Surg, Gynec and Obstet*, 59, 41-47, July, 1934
- <sup>13</sup> Lahey, F H. Reduction of Mortality in Hyperthyroidism. *New England J Med*, 213, 475-479, September, 1935
- <sup>14</sup> Hermann, L H. Thyrotoxicosis in the Negro. *Surg, Gynec and Obstet*, 55, 220, 1932
- <sup>15</sup> Maes, U, and McFetridge, E M. Place of Surgery in Therapy of Peptic Ulcer. *New York S J Med*, 36, 1399-1404, October, 1936
- <sup>16</sup> Boyce, F F, Veal, J R, and McFetridge, E M. An Analysis of Mortality of Gallbladder Surgery with Special Note on So Called Liver Death. *Surg, Gynec and Obstet*, 63, 43-53, July, 1936
- <sup>17</sup> Maes, U, and McFetridge, E M. Racial Trends (Negro and White) in Certain Surgical Diseases. *Am J Surg*, 33, 5-17, July, 1936
- <sup>18</sup> Boyce, F F, and McFetridge, E M. The Essential Clinical Considerations of Acute Appendicitis Based on Analysis of 2,715 Surgical Cases. *Internat Surg Digest*, 22, 195-213, October, 1936
- <sup>19</sup> Maes, U, Boyce, F F, and McFetridge, E M. Tragedy of Gastric Carcinoma. Study of 200 Surgical Cases. *ANNALS OF SURGERY*, 98, 619-631, October, 1933
- <sup>20</sup> Boyce, F F, and McFetridge, E M. Primary Carcinoma of Liver. With a Report of Twenty-Eight Additional Cases. *Internat Surg Digest*, 18, 67-80, August, 1934
- <sup>21</sup> Boyce, F F, and McFetridge, E M. Carcinoma of the Gallbladder. A Critique Based on an Analysis of 25 Cases from Charity Hospital in New Orleans. *Internat Surg Digest*, 21, 67-79, February, 1936
- <sup>22</sup> Lahey, F H. End-Results in Thyrocardiacs. *ANNALS OF SURGERY*, 90, 750, 1929
- <sup>23</sup> Sloan, E P. The Thyroid Surgery Syndromes. Treatment. C C Thomas, Springfield, 1936
- <sup>24</sup> Weller, C V. Hepatic Lesions in Association with Exophthalmic Goiter. *Tr A Am Physicians*, 45, 71, 1931
- <sup>25</sup> Kerr, W J. Necrosis of Heart and Liver in Thyrotoxicosis, with Some Notes on Possible Changes in Other Organs. *Northwest Med*, 29, 430, 1930

- <sup>26</sup> Kerr, W J , and Rusk, G Y Acute Yellow Atrophy Associated with Hyperthyroidism  
M Clin North America, 6, 445, September, 1922
- <sup>27</sup> Hashimoto, H Heart in Experimental Hyperthyroidism with Special Reference to Its  
Histology, Endocrinology, 5, 579, September, 1921
- <sup>28</sup> Goodpasture, E W Myocardial Necrosis in Hyperthyroidism J A M A , 76, 1545,  
June, 1921
- <sup>29</sup> Beaver, D C, and Pemberton, J deJ Pathologic Anatomy of Liver in Exophthalmic  
Goitre Ann Int Med , 7, 687-708, December, 1933
- <sup>30</sup> Cameron, G R, and Karunaratne, A E Liver Changes in Exophthalmic Goiter  
J Path & Bacteriology, 41, 267-282, 1935
- <sup>31</sup> Boyce, F F, and McFetridge, E M So-Called "Liver Death" Arch Surg , 31, 105-  
136, July, 1935
- <sup>32</sup> Boyce, F F, and McFetridge, E M The So-Called "Liver-Death" An Experimental  
Study of Changes in Biliary Ducts Following Decompression of the Obstructed  
Biliary Tree Arch Surg , 32, 1080-1086, June, 1936
- <sup>33</sup> Mora, J M Hepatic Lesion in Thyrotoxicosis Illinois M J , 68, 282-286, Septem-  
ber, 1935
- <sup>34</sup> Frazier, C H, and Brown, R B The Thyroid and Liver West J Surg , 43, 636-646,  
November, 1935
- <sup>35</sup> Frazier, W D, and Frieman, H Alterations in Liver Glycogen Following Thyroid,  
Iodine and Glucose Feedings Surg, Gynec and Obstet , 60, 27-29, January, 1935
- <sup>36</sup> Frazier, C H, and North, J P Carbohydrate Metabolism in Hyperthyroidism  
Trans American Association for Study of Goiter, 1933
- <sup>37</sup> Quick, A J The Synthesis of Hippuric Acid Am J Med Sci , 185, 630, May, 1933

## AN ANALYSIS OF THREE HUNDRED CONSECUTIVE THYROIDECTOMIES

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THE distribution of goiter in Alabama is largely confined to the northern part of the state, among the foothills of the Appalachian Mountains. Over 90 per cent of the cases reported here lived in this region. They were seen and treated in the eight years, 1928 to 1935, inclusive, and, living in a compact area, it has been comparatively easy to follow them. We have heard from every case either directly or indirectly, and in the great majority, we have seen them personally from time to time. The malignant goiters seen were beyond surgical help, and we undertook no thyroid operations for cardiac disease, because we were ignorant of the end-results.

The diagnosis of hyperthyroidism in mild cases is often quite difficult. There were 203 toxic cases and 97 nontoxic, making a ratio of practically two to one.

The border line between the slightly toxic and other conditions, particularly certain nervous conditions with a rapid heart, is often hazy and indefinite. In these cases, we have taken the stand that it is better to keep the patient under observation for months, and let time help in the diagnosis. In this way, there is less chance of imposing an unnecessary operation upon patients of the neurocirculatory asthenic type.

All cases with nodular goiters had roentgenologic examinations to determine the possibility of substernal adenomata.

As a general rule, cases with a pulse rate of 80, or under, were considered to be definitely nontoxic.

There was elevation of the blood pressure in 70 cases, and it was but little affected by operation. The typical high pulse pressure was often present in the younger toxic cases. I know of no other condition in which the systolic pressure is regularly almost twice the diastolic.

*Age* The oldest was 73 years, the youngest six. The average age was 34.6 years. There were 141 patients 35 years of age or older, 159 were under 35.

*Sex* There were 256 or 85.3 per cent females. There were 44 or 14.7 per cent males.

*Race* There were 273 whites and 27 Negroes, 229 white females, 44 white males. There were no males among the Negroes. The Negro population of Alabama is about 39 per cent of the whole.

*Types*—Toxic 203 or 67.6 per cent were toxic. Of these, 133 were diffuse, and 70 were nodular.

Nontoxic 97 or 32.4 per cent, nodular 83, diffuse (colloid) seven, fetal

adenomata two, aberrant thyroid two, chronic thyroiditis two, acute suppurative thyroiditis two

**Associated Conditions** One had a four plus Wassermann, three cyst of ovary, three diabetes, three pregnancy under four months, five severe myocarditis, three fibromyoma uteri

*Primary Symptoms in Toxic Cases in Order of Severity and Frequency* Nervousness 147, weakness 135, palpitation 91, loss of weight 67, exophthalmos 59, choking sensation 12, fever unexplained one. The greatest loss of weight was 121 pounds (from 211 to 90). This occurred during 12 months, during which time the patient took 30 drops of Lugol's solution daily. After operation in two stages, her weight returned in six months to 200 pounds. This case illustrates the futility of treating toxic goiter with iodine.

*Pathology*—The pathology of goiter is somewhat confused. It is cyclic in nature, and different phases may appear at the same time in the same gland.

**Diffuse Toxic.** Here the gland is nearly always enlarged, is symmetrical and feels quite firm. This firmness is accentuated by iodination. Microscopically, there is great hyperplasia of the epithelium, which is high and columnar, with infolding into the acini. The increasing epithelium largely replaces the colloid material, which may almost entirely disappear. This affords the anatomic basis for hypersecretion.

**Nodular Toxic.** Commonly called toxic adenoma. The most striking characteristic is its encapsulation. They vary in size from a match head to an orange, and are prone to undergo degeneration. Cystic formation is common. With each successive cycle, the cyst may enlarge, due to coalescing of adjacent cystic acini. Hemorrhage into cysts is frequent. Thyroid tissue surrounding the adenoma is hyperplastic and probably furnishes most of the thyroxin secreted.

**Diffuse Nontoxic.** The acini are large, filled with dense colloid material, the epithelium is low and flattened, and blood vessels are few. Scattering small areas of lymphoid hyperplasia can usually be found.

**Nodular Nontoxic.** The gross picture is essentially the same as that in toxic adenoma. Microscopically, the surrounding thyroid tissue does not show epithelial hyperplasia. Its chief offense is the causing of pressure symptoms, and it may become malignant. Ninety-six per cent of all malignant goiters arise in solitary adenomata.

**Chronic Thyroiditis.** Strangulation, destruction, and replacement of glandular epithelium by fibrous tissue, hypothyroidism often results. The gland is very hard, but is distinguished from carcinoma by the preservation of the normal lobulation and normal outline of the gland, although the latter may be indistinct.

*Preoperative Preparation for Toxic Cases*—Rest in bed 22 hours a day in severe cases, up an hour morning and evening. Increased fluids by mouth or intravenously. High caloric diet. Lugol's solution of iodine by mouth, usually 30 drops daily. It can be given intravenously in glucose solution. In

patients who show but little remission with iodine, drastic removal of thyroid tissue is indicated

Cardiac conditions, when present, were treated by the internist. Digitalis was given as in nongoitrous cardiac conditions.

When sufficient benefit was obtained from some, or all the above factors, operation was performed. Patients who were iodine-fast, or had been taking iodine for a long time, were taken off iodine for eight to ten weeks, and then reiodinized intensively for eight to ten days prior to operation.

There were 16 multiple stage operations, 14 were performed in two stages, while two cases were performed in three stages, ligation representing the first stage. At the first operation we removed the isthmus and one lobe, usually the right, six to eight weeks later, the operation was completed. The decision to perform the operation in two stages was definitely arrived at before operation, after carefully considering the general condition of the patient. It was not made during the operation.

*Indications for Operation*—To prevent further damage to the heart and circulatory system, to arrest process of autodestruction, to relieve pressure symptoms, for cosmetic reasons, and in the adenomata cases to forestall toxicity, and to prevent the development of malignancy in discrete adenomata.

*Operative Technic*—First and most important of all is a good exposure of the operative field. One should never hesitate to sever ribbon muscles. It is better to cut them than to risk injuring a nerve.

*Removal of Adequate Amount of Thyroid Tissue*. Only actual experience can teach this.

*Ligation of Superior Poles*. This materially cuts down bleeding and helps mobilize the gland.

*Ligation of Middle Thyroid Vein*. This should be accomplished early in the operation, otherwise, it is easily torn, retracts and causes annoying hemorrhage.

*Removal of Isthmus* from the anterolateral aspect of the trachea, thus removing pressure on it.

*Ligation of Inferior Thyroid Artery* is occasionally done, in order not to have to grasp later for bleeding points in the region of the recurrent nerve.

*Removal of Pyramidal Lobe*, when present.

Thyroid Remnant turned inward and sutured to the trachea, which helps to stop oozing, restores the normal outline of the neck, and in cases of secondary operation greatly facilitates the exposure of the gland.

*Complete Hemostasis*

*Closure Without Drainage*

*Complications*—Drainage in thyroid surgery should be considered as a complication. It was deemed necessary in 25 operations, 15 of which were for substernal goiter. The drain was usually removed after one or two days.

Multiple Stage Operations were performed on 16 very severe cases, where it was feared that the complete operation might result in a fatality. As evidence of the severity of this group, two of them died within four months after

the operation, however, not from thyroid disease. One of them had gained 22 pounds and the other about 15.

Substernal goiter was present in 15 cases and offered no unusual difficulty in operation. They were all drained. Severe postoperative crises occurred in three cases and required energetic treatment. Lugol's solution may be given intravenously in 5 per cent glucose solution, as much as 50 minims in a liter, every three or four hours in the severe cases.

The oxygen tent was considered very helpful in two of these cases. Postoperative fibrillation occurred in seven cases and was definitely helped by giving quinine. Postoperative bleeding was present in one case and was found to be in the skin flap where it was easily controlled. The trachea was accidentally opened once, where an adenoma had greatly compressed it. By suturing the muscle against the trachea, it caused no trouble, and this patient went on to develop a pyloric obstruction 18 months later, which was relieved by operation. There was one postoperative infection, from which there was no untoward result. Injury to the recurrent nerve occurred once in a patient, while removing a large adenoma, who had been operated on previously elsewhere. Tetany did not occur in any case.

The average stay in the hospital was 8.2 days and in the last 100 cases the average stay was only five days.

**Anesthesia.** Preliminary sedation was employed with good effect in all cases. We now give nembutal Gr. 3 one and one-half hours before operation and morphine Gr. 1/6, scopolamine Gr. 1/200, 45 minutes before operation. This is varied at times. In the weak and feeble, atropine may be substituted for scopolamine.

In 20 cases operated upon at the Charity Hospital, ether was used. In the early cases of this series, novocain infiltration was used in 48 private cases. At that time we did not have good anesthesia. Since 1930, with good anesthesia, we have operated upon the last 232 cases of this series with nitrous oxide and oxygen. Since September, 1936, we have used cyclopropane exclusively, and like it much better than any other anesthetic for thyroid surgery.

**Pulse Rate.** The average pulse rate on admission was 100. The average pulse rate in a group of 116 very toxic cases on admission was 110. The average postoperative pulse rate was 80.

**Basal Metabolism.** This was ascertained in 282 of the 300 cases. The highest obtained was plus 78. This same case had been estimated under the same conditions elsewhere at plus 104. The lowest basal metabolism in a definitely toxic case was minus five. The lowest basal obtained on admission was minus 21. A good many of the nontoxic cases, particularly the nontoxic nodular type, who had a low basal metabolic rate, approximating minus 15, showed a rise to normal after the operation.

**Results.** Those obtained on the whole were highly satisfactory. There was complete operative recovery of 299 cases. One patient died four days after operation. This patient was 67 years old, was unable to walk when she entered the hospital, had severe myocarditis, arrhythmia, edema, and should

## THYROIDECTOMY

not have been subjected to operation. She had been twice in the hospital before, and had been given roentgen therapy by her attending physician. Of the three recurrent cases, two have been reoperated upon, one of which still remains uncured. Five of the six persistent cases have been reoperated upon and four appear cured, while one continues to show mild hyperthyroidism. One hundred twenty-two, or 60 per cent, of the toxic cases gained an average of 15 pounds, 282 cases, or 94 per cent, of all types, either gained or remained stationary, 18, or 6 per cent, lost weight, and did not do well on the whole. The recurrent and persistent cases were among these.

One of the striking results of operation was relief from nervousness. In only one case was there a marked relief from hypertension. This was in a boy of 19, and this did not become manifest until a year had elapsed.

The follow up record may be of interest. One young woman, pregnant, very toxic, developed mania, was incarcerated, recovered. One young man developed perforated duodenal ulcer eight months after thyroidectomy. A pyloroplasty was performed and he recovered. One woman, age 52, developed pyloric obstruction 18 months later, a gastro-enterostomy was performed, and she has remained well four years. One young woman developed hypertrophy of the pyramidal lobe, which was disfiguring, 12 months after operation. It was removed. A man, age 34, very toxic, died eight weeks after hemithyroidectomy from acute lobar pneumonia. He was sick only three days. Up to the time of his last illness, he had gained 15 pounds and was ready for the second stage operation. One woman, age 36, died four months after the second stage operation from complications following influenza. She developed a thrombosis of the right axillary vein with great swelling and edema of the extremity. She had gained 22 pounds between the operation and the beginning of her last illness. One young woman died 12 months after operation in diabetic coma. One woman, age 50, died, in a neighboring state, following an abdominal operation, in which the gallbladder and an ovarian cyst were removed at the same time. Two patients more than 65 years of age died five years after operation, with symptoms of hypertension and cardiac failure.

In conclusion, we wish to say that nothing original is claimed in presenting this small series of cases. Perhaps the only worth while point is that a low mortality rate was obtained. This we feel was the result of attention to details, and, particularly, by refusing to operate upon patients not properly prepared.

### CONCLUSIONS

- (1) Hyperthyroidism is at times difficult to diagnose.
- (2) Great care should be used in arriving at the decision to operate upon bad risk cases.
- (3) Multiple stage operations are indicated in some of the most severe cases.
- (4) Correct and complete preoperative preparation is essential to the patient's safety, and will reward the surgeon with a gratifying mortality rate.

# TOTAL THYROIDECTOMY FOR HEART DISEASE

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THE proper evaluation of any new therapeutic agent or method is always difficult—particularly so when the disease being treated is chronic in character and subject therefore to natural exacerbations and remissions. If the operation of total thyroidectomy proves of unquestioned value in the treatment of congestive heart failure and angina pectoris, much will be added to the armamentarium of those who labor, often with so little success, to relieve the chronic cardiac invalid. It is, therefore, of importance that repeated attempts be made to evaluate this method of treatment. We believe that a sufficient number of patients have now been treated by total thyroidectomy, and that enough time has elapsed since the operation was first advocated, in 1933, by Blumgart, Levine and Berlin to clarify our ideas in regard to the results. That sharp differences of opinion as to the value of this procedure do exist may be readily ascertained by even a casual survey of the literature pertaining to the subject. Clute<sup>9</sup> is as yet not convinced that the results obtained warrant the operation except in cases of severe angina. Mont Reid<sup>47</sup> thinks the entire procedure of total thyroidectomy unsound and unjustified. Trout<sup>56</sup> has not been sufficiently impressed with the duration of improvement to advise any patient to subject himself to the hazards of the operation, and Moore<sup>35</sup> feels it so unphysiologic that he has never advised its performance. On the contrary, Pemberton<sup>41</sup> thinks the operation rests upon sound physiologic principles, and Bienzer<sup>5</sup> has been quite enthusiastic as to the results he has obtained. Between the vigorous endorsement of the originators and other proponents of the operation and the strongly adverse opinions of surgeons and cardiologists of equal repute, there must be a middle ground far more tenable, and it is quite likely that somewhere between the extreme views mentioned there lies the real truth.

To rely entirely upon the published data concerning any new therapeutic procedure is apt to lead one to erroneous conclusions. It is uniformly true that advocates of any new method are more prolific in their writing than are those whose experience has been less fortunate. We propose, therefore, to tabulate, in so far as we are able, data concerning all cases on whom the operation has been performed, even though many of these cases have not appeared in the literature, and, from this study, to surmise if the end-results obtained show the operation to have merit, to indicate what patients, if any, should be subjected to the operation and to make certain general comments pertinent to the entire procedure. Our own cases we present with the general



tabulation The material offered was obtained from a fairly complete survey of the literature and from an inquiry sent to all members of the American, the Southern and the Western Surgical Associations, the American Association for the Study of Goiter and certain other American clinics Six hundred seventy-seven inquiries were mailed and answers were obtained in 342 instances Only 59 individuals or clinics reported a definite number of cases in which the operation had been performed A number of other individuals appeared to have had some experience with the operation, but the data given were not in form adaptable for our studies

We have data concerning 362 upon whom the operation was performed Except in regard to complications, the results will be recorded separately in the angina pectoris and the congestive heart failure groups Information concerning complications was obtained on 291 cases In this group tetany occurred 30 times (10.3 per cent), though fortunately, in all but one instance, it was transient in duration, in this instance it appears to have been the cause of death Injury to the recurrent laryngeal nerve occurred on 24 (8.2 per cent) occasions, and this complication likewise was usually of transient nature In no instance was there bilateral nerve damage As would be expected, all operators have been alert to these major complications, which, at least theoretically if not always practically, are avoidable We believe that serious complications are not sufficiently frequent to militate greatly against the procedure It is however, probably true that total thyroidectomy has been attempted chiefly by those possessing a relatively wide experience with thyroid surgery and unquestionably, the operation ought not to be attempted by others

We do not wish at this time to discuss the rationale of total thyroidectomy in the treatment of heart disease Probably multiple factors are involved Of the various views expressed, it appears to us that the one most tenable would indicate that we should expect the best results in patients with angina pectoris For that reason we have elected to consider the results in angina and in congestive heart failure separately

For congestive heart failure there have been 229 operations performed In this group there occurred 24 (10.48 per cent) operative deaths We have considered as operative deaths those individuals who died within a short time after operation, usually within the first week This is considered representative of the amount of immediate increased hazard which the operation entails

The results are grouped in four classes By "excellent," we mean that there has been no recurrence of symptoms or signs, in spite of activity greater than that enjoyed preoperatively The majority of these individuals have been restored to a more normal life "Moderately improved" indicates that the attacks are less frequent and less severe, even with increased activity "Slightly improved" indicates that attacks are somewhat less frequent and less severe and the patient more comfortable though the range of activity is little changed All other results are classified as showing "no improvement" The results given here do not include the operative deaths To do so would naturally increase the percentage of failures, but it must be remembered that

a considerable number of the cases here reported were among the first operated upon at the Peter Bent Brigham Hospital and the Beth Israel Hospital before either of these institutions had thoroughly established their criteria for the selection of cases, and many of those who represent failures are now known to have been poor subjects for the operation. Each of these institutions, pioneers in this field of work, is now performing a lesser number of operations on a more carefully chosen group of patients, and their results will be found correspondingly improved.

The immediate operative mortality encountered in the series being reported of patients suffering congestive heart failure compares very satisfactorily with that of 12 per cent reported by Mixer, Blumgart and Berlin<sup>1</sup> in an experience of 46 cases, and is only slightly higher than that of 9.3 per cent found by McCreery and Weeks<sup>34</sup> on 150 cases reported from their questionnaire.

In our series of collected cases, 71 patients, or 34.63 per cent, showed excellent results. Fifty-nine, or 28.78 per cent, showed moderate improvement, six, or 2.92 per cent, were only slightly improved and 69, or 33.65 per cent, were classed as unimproved and failures. Our data correspond reasonably well with those of Weeks and McCreery, though Mixer, Blumgart and Berlin's figure of only 7 per cent failure is far lower. If we combine groups one and two, considering the total as constituting those with satisfactory improvement, a percentage of 63.41 per cent is obtained in comparison with 81.1 per cent reported by Weeks and McCreery and 76 per cent by Mixer, Blumgart and Berlin. On the contrary, Clark, Means and Sprague<sup>8</sup> found only one-fourth, or 25 per cent, of their cases to have shown improvement, and three-fourths, or 75 per cent, were recorded as failures. We believe that the true figure for satisfactory results, following thyroidectomy for congestive heart failure, to be approximately 60 per cent.

We desire now to consider the data obtained from a study of 133 operations performed for angina pectoris. In this group, the operative mortality was 3.75 per cent (five), essentially the same as recorded in Weeks and McCreery's series (3 per cent). In the smaller group of Mixer, Blumgart and Berlin, there were no deaths. In the series being recorded, 71 patients, or 55.46 per cent, showed excellent results. Thirty-six, or 28.12 per cent, were moderately improved. Five, or 3.9 per cent, were slightly improved and 16, or 12.5 per cent, were classed as failures. These figures correspond fairly closely with the group of Mixer, Blumgart and Berlin and of McCreery and Weeks. Again considering the first two classes as satisfactory, we find 83.58 per cent good results, as compared with 85 per cent and 91.4 per cent, respectively, by the two observers previously referred to. We believe that the correct figure for good or satisfactory results in the cases of angina pectoris lies between 80 and 90 per cent.

Our statistics, tabulated in Table I, indicate that neither the operative mortality nor the type and number of complications to be expected are sufficiently great to deter us from applying this operation *when indicated*. It appears that there is a slightly more than 50 per cent chance of satisfactory

TABLE I

STATISTICAL RESUMÉ OF 226 CASES OF CONGESTIVE HEART FAILURE AND 133 CASES OF ANGINA PECTORIS OPERATED UPON BY TOTAL THYROIDECTOMY, AND THE RESULTS OBTAINED\*

Surgeon	CARDIAC CONDITION		RESULTS							
	C H F	Angina	C H F				Angina			
	Number of Cases		No	No	No	No	No	No	No	No
			1	2	3	4	1	2	3	4
Allen, Dufl <sup>1</sup>	9	2	2	2		5	1			1
Beth Israel Hospital <sup>2</sup>	46	23	25	12		3	7	12		4
Bisgard, J O <sup>3</sup>	2	2		1		1	2			
Booth, A E <sup>4</sup>	2	0		2						
Brenizer, A G <sup>5</sup>	3	5	1	1			5			
Brooks, Barney <sup>6</sup>	1	0				1				
Chapman, D G <sup>7</sup>	1	0	1							
Clark, R J <sup>8</sup>	19	2		3		13		1		1
Davidson, T C <sup>10</sup>	2	1	2				1			
Duke University <sup>11</sup>	1	0	1							
Eutime, Donald <sup>12</sup>	2	0		1						
Fahrni, G S <sup>13</sup>	0	2					2			
Felger <sup>14</sup>	3	4	1	1		1	3			1
Gallie, W E <sup>15</sup>	4	5	1			2	5			
Gatewood <sup>16</sup>	1	1	1				1			
Gillett, N W <sup>17</sup>	3	2	1	1				2		
Graham, Roscoe <sup>18</sup>	0	4					3			1
Grove, Lon <sup>19</sup>	2	0	1		1					
Jackson, Arnold <sup>20</sup>	5	1	1	2		1		1		
Jones, Elmer <sup>21</sup>	0	1						1		
Lee, W E <sup>22</sup>	2	0				2				
Lehman, E P <sup>23</sup>	1	0				1				
Link, G <sup>24</sup>	1	0	1							
Maes, Urban <sup>25</sup>	6	0		2		2				
Mahon, G O <sup>26</sup>	1	1		1				1		
Mastin, E V <sup>27</sup>	3	0	2	1						
McClure, R D <sup>28</sup>	2	3	1	1			1	2		
McGhee, J L <sup>29</sup>	2	0	1			1				
McNealy, R W <sup>30</sup>	3	1		1				1		
Miller, E L <sup>31</sup>	4	3	3	1			3			
Miller, Richard H <sup>32</sup>	8	0		1		6				
Miscellaneous	5	0		3		2				
Morton, Bruce <sup>36</sup>	3	0				3				
Morton, J J <sup>37</sup>	6	2				6	2			
Ochsner, Alton <sup>38</sup>	4	1	1	2		1	1			
O'Keefe, M E <sup>39</sup>	4	0		3		1				
Parsons, Barclay <sup>40</sup>	5	5	1	3		1	1	2		1
Parsons, W H and Purks, W K	2	3	1	1			1	1		
Percy, N M <sup>42</sup>	3	1	1	1		1	1			
Peter Bent Brigham Hospital <sup>43</sup>	15	27	6	2	3	3	12	8	4	
Phemister, D B <sup>44</sup>	1	0				1				

\* No 1, Excellent results No 2, Moderate improvement No 3, Slight improvement  
No 4, Failure to improve

TABLE I (Continued)

Surgeon	CARDIAC CONDITION		RESULTS							
	C H F	Angina	C H F				Angina			
			Number of Cases				No			
			No	No	No	No	No	No	No	No *
			1	2	3	4	1	2	3	4
Ravdin, I S <sup>11</sup>	9	12	3			6	7			5
Reichert, F L <sup>16</sup>	1	1		1			1			
Rice, Carl O <sup>18</sup>	9	0	5	4						
Schwytzer, A <sup>19</sup>	1	0			1					
Schier, H V B <sup>50</sup>	0	5					1			1
Smith, M K <sup>11</sup>	0	1								1
Soley, Mayo <sup>20</sup>	0	1					1			
Straus, D C <sup>23</sup>	2	2				2		2		
Sturgeon, C I <sup>11</sup>	0	2					1	1		
			1	2	3	4	1	2	3	4
Taylor, W A <sup>50</sup>	0	1					1			
Weeks-McCreery <sup>11</sup>	10	6	3	4		2	4	1	1	
Wise, W D <sup>23</sup>	5	0	4	1						
Yates, J L <sup>19</sup>	2	0			1	1				
Total	226	133	71	59	6	69	71	36	5	16

improvement in cases with congestive heart failure and somewhat better than 75 per cent satisfactory results in angina pectoris. Quite candidly it must be said that we have been surprised at the extremely low operative mortality in the angina pectoris group and at the extremely high percentage of satisfactory improvement in this group.

Aside from statistical data concerning the results of total thyroidectomy in heart disease, there are other considerations of importance. No one may say as yet, definitely, whether the operation prolongs life. It is admittedly only a form of symptomatic treatment which in no way alters the underlying cardiac pathology. We must bear in mind that we are treating one disease by the substitution of another, even though the latter, myxedema, is milder and more amenable to treatment. One also must insist that patients operated upon remain under treatment for the remainder of their lives. The internist who recommends the operation or the surgeon who executes it must bear in mind that if the patient, by reason of one cause or another, falls into the hands of other physicians not willing or able to continue the proper post-operative care, he becomes a pitiable problem. On the contrary, it must in fairness be recalled that patients subjected to the operation have, in most instances, been totally incapacitated and have suffered miserably because of their cardiac disease which has failed to respond to medical treatment, for surgery should not be resorted to under other circumstances. We are not justified in demanding perfection of a method applied to such patients.

Finally, we feel that total thyroidectomy is a valuable addition to the treatment of angina pectoris and congestive heart failure. It is imperative, however, that the accessibility of this procedure should in no wise lessen our attempts to control all cardiac problems by nonsurgical means. The selection

of cases must be very carefully considered. The greater probability of worth while results is to be expected in patients with angina pectoris

# BIBLIOGRAPHY

- <sup>1</sup> Allen, Duff Personal communication
- <sup>2</sup> Beth Israel Hospital Total Ablation of the Thyroid for Angina Pectoris and Congestive Heart Failure Results of Eighteen Months' Experience Minter, Charles G, Blumgart, Herrman, L, Berlin, David D ANNALS OF SURGERY, October, 1934
- <sup>3</sup> Bisgard, J O Personal communication
- <sup>4</sup> Booth, A E Personal communication
- <sup>5</sup> Brenizer, A G Personal communication
- <sup>6</sup> Brooks, Barney Personal communication
- <sup>7</sup> Chapman, D G Personal communication
- <sup>8</sup> Clark, Richard J, Means, James H, Sprague, Howard B Total Thyroidectomy for Heart Disease New England Jour Med, 214, No 7, 277-294, February 13, 1936
- <sup>9</sup> Clute, H M Personal communication
- <sup>10</sup> Davidson, T C Thyroid Surgery in Cardiac Patients The Southern Surgeon, 3, No 2, 103-111, June, 1934
- <sup>11</sup> Duke University Personal communication
- <sup>12</sup> Eutene, Donald Personal communication
- <sup>13</sup> Fahim, G S Personal communication
- <sup>14</sup> Felger Personal communication
- <sup>15</sup> Gallie, Wm Edward Discussion Paper Cutler and Schmitkei, Total Thyroidectomy for Angina Pectoris ANNALS OF SURGERY, 100, No 4, 598, October, 1934
- <sup>16</sup> Gatewood Personal communication
- <sup>17</sup> Gillett, N W Personal communication
- <sup>18</sup> Graham, Roscoe Personal communication
- <sup>19</sup> Grove, Lon Personal communication
- <sup>20</sup> Jackson, Arnold Personal communication
- <sup>21</sup> Jones, Elmer Personal communication
- <sup>22</sup> Lee, W E Personal communication
- <sup>23</sup> Lehman, E P Personal communication
- <sup>24</sup> Link, G Personal communication
- <sup>25</sup> Maes, Urban Discussion Paper Ochsner, Alton, reference 38
- <sup>26</sup> Mahon, G O Personal communication
- <sup>27</sup> Mastin, E V Personal communication
- <sup>28</sup> McClure, R D Personal communication
- <sup>29</sup> McGehee, J L Personal communication
- <sup>30</sup> McNealy, R W Personal communication
- <sup>31</sup> Miller, E L Personal communication
- <sup>32</sup> Miller, Richard H Personal communication
- <sup>33</sup> Minter, Charles G, Blumgart, Herrman L, and Berlin, David D Total Ablation of the Thyroid for Angina Pectoris and Congestive Heart Failure ANNALS OF SURGERY, 100, No 4, 570-577, October, 1934
- <sup>34-7</sup> Weeks, Carnes Total Thyroidectomy for the Relief of Pain in Angina Pectoris Surgical Clinics of N Amer, 16, No 3, 667-679, June, 1936
- McCreery, John A Total Thyroidectomy for Congestive Heart Failure and Angina Pectoris ANNALS OF SURGERY, 103, No 1, 136-139, January, 1936
- <sup>35</sup> Moore, John T Personal communication
- <sup>36</sup> Morton, B Personal communication
- <sup>37</sup> Morton, J J Personal communication
- <sup>38</sup> Ochsner, Alton, and Gillespie, Crawford Total Thyroidectomy for Cardiac Disease New Orleans Medical & Surgical Journal, 88, No 7, 423-432, January, 1936

- <sup>10</sup> O'Keefe, M E Personal communication
- <sup>10</sup> Parsons, Barclay Personal communication
- <sup>11</sup> Pemberton, J B Personal communication
- <sup>12</sup> Percy, N M Personal communication
- <sup>11</sup> Peter Bent Brigham Hospital Further Experiences with Total Thyroidectomy in the Treatment of Intractable Heart Disease Levine, Samuel A, and Eppinger, Eugene C American Heart Journal, 10, No 6, 736 August, 1935 Thyroidectomy in the Treatment of Advanced Congestive Heart Failure and Angina Pectoris Levine, Samuel A, Cutler, Elliott C, and Eppinger, Eugene C New England Jour Med, 209, No 14, 667-679, October 5, 1933
- <sup>11</sup> Phemister, D B Personal communication
- <sup>1</sup> Ravdin, I S Personal communication
- <sup>46</sup> Reichert, F L Personal communication
- <sup>47</sup> Reid, Mont Personal communication
- <sup>15</sup> Rice, Carl O Personal communication
- <sup>10</sup> Schwyzer, A Personal communication
- <sup>50</sup> Schier, H V B Personal communication
- <sup>1</sup> Smith, M K Personal communication
- <sup>7</sup> Soley, Mayo Personal communication
- <sup>3</sup> Straus, D C Personal communication
- <sup>71</sup> Sturgeon, C T Personal communication  
Tavlor, W A Personal communication
- <sup>50</sup> Trout, H Personal communication
- <sup>7</sup> Weeks-McCreery Reference 34
- <sup>1</sup> Wise, W D Personal communication
- <sup>1</sup> Yates, J L Personal communication

## DISCUSSION OF THE PAPERS OF DOCTORS MAES, DIENNEN, AND PARSONS

DR ADDISON G BRENZER (Charlotte, N C) —The explanation of the death in the Negroes was that the Negro with a thyrotoxicemia of a grave type does not appreciate his condition and is usually a neglected case. Apparently Doctor Maes has encountered some very badly burned out cases in this race.

As to Doctor Diennen's paper with the small percentage of Negro incidence, I do not understand that for there is no doubt that Negroes do have exophthalmic goiters. I think Doctor Biam of Philadelphia said he had never seen a Negro with exophthalmic goiter. The figures are very interesting to me. We do not like to quote our mortalities, for if the rate is good we might be suspected of having it too good, but I cannot understand how one surgeon in Birmingham has about one-third of 1 per cent and another, equally good surgeon, in New Orleans would have such a high mortality. My first 100 cases had a much higher mortality than my later ones but I do not think that accounts for this discrepancy in mortality of these two authors. One surgeon may have a run of a certain type of severe cases of goiter or select such cases which yield a high mortality. This spring, three of my cases died in the hospital while being prepared for operation. It is obvious that they would all have died, had they been operated upon.

The distribution of the cases cited by Doctor Maes was among about 25 young surgeons, whereas the work of Doctor Diennen was by one man, who apparently has operated upon a class of case of less severity than those encountered by Doctor Maes. Doctor Parsons has quoted me in favor of total thyroidectomy, particularly in cases of badly damaged hearts with angina where the patient should be markedly slowed down. While I am heartily in favor of total thyroidectomy in such cases, carefully selected, I have performed many less operations upon them than he has.

DR WILLIAM D HAGGARD (Nashville, Tenn) —I think the differences between the New Orleans and the Birmingham statistics are probably overlooked by Doctor Bienizer because Doctor Maes reported a larger percentage of Negroes. I think Doctor Maes is to be congratulated upon the reduction of his mortality, as is Doctor Diennen for his excellent presentation of his experiences and results. I think Doctor Maes can be comforted by the fact that the Royal Infirmary of Edinburgh reported 12.4 per cent and the Royal Infirmary of Liverpool 12.8 per cent mortality. It would seem as if mortality was on the decline. In our last 300 cases we had only two deaths. I speak of this because I feel that we could have prevented these. One patient, an elderly, enormous woman, was operated upon successfully, but on the ninth day was found dead in bed. The other case was that of a tense, turgid man with acute hyperthyroidism that we did not sufficiently prepare, although he was given Lugol's solution, and did not use the best method for his particular case.

I think we must always take into consideration the mental attitude of the patient, for we know the patient who is nervous, tense and irritable is not a good risk. This man's basal metabolism went down to about 21, his pulse was 110, and we thought he was ready for operation. I belong to the school that believes in multiple operations, but in this case I thought I was so good I did not have to do that. I should have used only preliminary ligation. Personally, I would rather ligate and find out what they will stand. We have seen patients die even from ligation, but I think this man would have been saved by it. Our improvement has been so great with the use of Lugol's solution that we have lost sight of the necessity for choosing the multiple operation.

DR FRANK H LAHEY (Boston, Mass) —I have been very much interested in these papers, and particularly to see the improvement that has taken place in New Orleans since Doctor Maes' last paper. This does, I think, illustrate a point which is interesting, and that is that a concentrated interest in thyroids will reduce the mortality, and a limited number of men performing thyroidectomies will reduce the mortality still further. As long as many men do only a few thyroidectomies, we will never reduce the mortality to where we wish it.

In a recent paper read before the American College of Surgeons at Philadelphia, I presented the work of Dr E. C. Bartels in our Clinic on the hippuric acid determinations of liver function. We have demonstrated, I think beyond any reasonable doubt, that in the severe stages of hyperthyroidism, there is a diminished liver function as demonstrated by hippuric acid tests, that during the period of preoperative preparation, this is elevated, that during the period of postoperative reaction, the liver function, in terms of hippuric acid determinations, is again diminished and that when the basal metabolism returns to normal and the patient is relieved of his hyperthyroidism, hippuric acid determinations reach their normal range of 2.8 to 3 Gm. We do not believe, however, that hippuric acid determinations of liver function are of any great value in determining operability. When a patient is so seriously ill from hyperthyroidism that his liver function, in terms of hippuric acid determination, is definitely diminished, there will be many other evidences that should make one assume that the patient falls into the bad risk group.

The selection of bad risks can only be the result of the accumulation of a mass of data which must be assembled and appreciated and based solely upon experience, before one can segregate those patients who have severe grades of hyperthyroidism in whom there is a danger of a fatality, from those with less severe grades in whom one stage operations may be performed safely.

One of the outstanding facts that has been impressed upon us in the selection of thyroid risks is that there never has been, and probably never will be, any substitute for experience.

There are facts which should be presented on this subject, that particularly relate to statistics, and I wish to be careful that no one assumes that these figures are presented in any comparison whatever with the groups already presented. It pleases me very much that Doctors Diemen, Maes and Parsons are doing such splendid work with thyroid states, and I speak of numbers after they have spoken of numbers, only that I may prove the point which I wish to make.

We have now performed 15,300 thyroid operations on 13,000 patients. Of these, 111 died while in the hospital. These include every death that occurred from any known cause, such as those who developed typhoid, measles, or one patient who stumbled on the top step and broke her neck and so forth. During that same time, 53 patients died while in the hospital upon whom no operation had been performed. Of those who died following operation, 40 per cent died in crisis, 10 per cent of emboli, and 10 per cent of heart failure. During the same time 33 per cent of those who had had no operation died in crisis, 14 per cent of emboli and 15 per cent died of heart failure. This means that almost all of these deaths were avoidable deaths. The Bureau of Vital Statistics in Massachusetts, New York and Pennsylvania have informed me that during a period of six years, in these three states, they had recorded 5,321 patients who, during this period, had died thyroid deaths, most of them without operation. If we could operate upon 15,000 people with 111 deaths and if 5,321 died in six years in these three states, we must do something about it. Since a third of them died in crisis they would not have died had they been operated upon earlier. Since 10 to 14 per cent died of emboli, they would probably not have had emboli if they had been operated upon earlier and had not had auricular fibrillation, and since 10 to 15 per cent died of heart failure, most of these hearts would not have failed if they had not had hyperthyroidism over a long period of time.

I wish particularly to urge three points. First, as soon as any patient with hyperthyroidism shows any increase in intensity of his symptoms, one should drop conservative measures and resort to surgery, second, when there are any evidences of an impending crisis likewise, one should drop conservative measures and resort to surgery, third, auricular fibrillation is accepted altogether too lightly and, in my opinion, should be an immediate indication for surgery in hyperthyroidism. You do not have emboli as a rule until patients' hearts begin to fibrillate. They do not fibrillate as a rule unless they have heart damage and hyperthyroidism. Therefore, if you have a patient with hyperthyroidism and he develops fibrillation, that in my opinion, becomes an immediate and urgent indication for thyroidectomy.

I would like to say something about total thyroidectomy, and if I do not seem enthusiastic about it, convictions have been arrived at on personally operated cases, and others, now amounting to 27 in number, that we have carefully followed and are being reported. The number of good results in this series is, in our opinion, not sufficient to make us entirely pleased with them. I do not believe that this operation will endure as a much practiced procedure for the following reasons. First of all, any patients who are operated upon for cardiac decompensation by total thyroidectomy have, of necessity, a very limited cardiac reserve, secondly, one must produce a myxedema, and it is accepted that myxedema is an undesirable state for a decompensated heart. Therefore, it is said that these patients should be given thyroid extract until they are maintained at approximately a minus 25 metabolism. We feel the-



oretically, and based upon our experience in this limited number of cases, that this is too complicated a position to maintain with any degree of accuracy, and in the majority of cases of cardiac decompensation upon whom total thyroidectomy has been performed, they have had a return of their decompensation or have died. In the cases of angina pectoris, there have been a few cases who have been distinctly benefited and if a patient is willing to exchange an active state for the sluggish state associated with myxedema, there are undoubtedly certain cases in which the anginal pain can be modified.

Total thyroidectomy is a difficult operation. It is one in which there will be a very definite mortality, it is one in which there has been in many hands a high percentage of complications. It demands the highest degree of technical skill and an intimate knowledge of the anatomy of the thyroid. It, therefore, should not be undertaken lightly. I believe as years go on, it will occasionally be employed for the well selected patient, the selections being made largely by a competent cardiologist in terms of the amount of cardiac reserve. I believe, on the other hand, that as the years do go on, the total number of cases operated upon by total thyroidectomy will, as it seems to me they are now doing, progressively diminish.

DR URBAN MAES (closing) —Three years ago, after I had read my very pessimistic first paper on thyroid disease before this organization, I thought I would take a train in the opposite direction instead of going home. To my great surprise, I found the New Orleans surgeons rather enthusiastic about the truthful report we had made on the subject, and it is gratifying to find that a sharp drop in the mortality of thyroid surgery has occurred since that time. On the other hand, we must remember that it is going to take surgeons of the South a long time to become proficient in this branch of surgery. We see too few cases. That is proved by the large number of surgeons who handled this relatively small number of patients.

The estimation of liver function is only one factor in the general estimate of the patient with thyroid disease, but it is a very important consideration, and disregard of it will appreciably increase the mortality. Patients with a low liver function run a rather poor chance after thyroid surgery. I want to stress again and again that this is only one factor to be considered, but I also want to stress that it is a most important one, and it is more important, I believe, where experience in thyroid surgery is limited, than where it is extensive. Perhaps, if we give this factor sufficient weight, we may reduce the mortality of thyroid surgery in New Orleans to something approaching the mortality Doctor Lahey achieves in Boston. That is a consummation devoutly to be wished, but one not likely to be achieved, I fear, in the community from which we come.

DR WILLARD H. PARSONS (closing) —Because he speaks, and rightly so, with the voice of authority, Doctor Lahey's antipathy to the procedure in question will tend to consign total thyroidectomy for cardiac disease to an early, and, we believe, possibly untimely death. Yet careful analysis of his remarks indicates that certain of his conclusions are not different from our own.

No one could maintain that the operation is ideal, and none could deny that for technical and other reasons it should not be lightly undertaken. Likewise it does, as Doctor Lahey remarks, convert an individual formerly alert to a somewhat vegetative existence. At that, such a conversion may be a fate more kindly than its predecessor. In considering the disadvantages incident to the thyroidectomized patient, we must, in fairness, consider also the dis-

advantages to the individual from the disease because of which treatment is undertaken

We agree with Doctor Lahey that the principal value of the operation is in the management of patients having angina pectoris rather than congestive heart failure. We have said, and we repeat, that total thyroidectomy, admittedly an objectionable procedure, should be reserved for a small, though definite, group. In that small refractory group, meeting the qualifications emphasized by other authors and by ourselves, until some more effective or desirable form of therapy is suggested, we think total thyroidectomy worthy of trial.

Before abandoning a procedure which, if the literature is to be believed, has been of value in rather a high percentage of cases, we must inquire if some therapy, at least equal if not more efficacious, is offered.

## FACTORS OF SIGNIFICANCE IN THE PROGNOSIS OF CANCER OF THE STOMACH

DONALD C BALFOUR, M D

ROCHESTER, MINN

ANY discussion of cancer of the stomach should include some reference to the problem of early diagnosis. Cancer of the stomach in its early stages is so situated that in probably 90 per cent of cases the lesion could be satisfactorily removed, yet the present operability in the disease is only between 20 and 25 per cent. Of no other form of cancer is this paradox as true. The chief reason for this is the absence of definite symptoms in the early stages of the disease, and the hope of any advances in detecting the disease in this operable stage rests on the alertness of the layman and the physician to the facts that cancer of the stomach is by far the most common organic disease of the stomach and that there are methods of determining whether or not the disease is present. The skilled roentgenologist, in 95 per cent of cases, can visualize organic lesions of the stomach, although concerning approximately 20 per cent of these a definite opinion as to the nature of the lesion is not warranted. This inability to distinguish between some of the lesions is also the experience of the surgeon, and it is frequently true that not until microscopic examination is possible is the true nature of the lesion revealed. To what extent the gastroscope, in skilled hands, can improve this situation remains to be seen, but it seems reasonable to believe that any method which satisfactorily will allow visualization of the entire mucosal area of the stomach, holds great possibilities for development.

The curability of cancer of the stomach by surgical removal of the growth has been well established. When the growth and the regional lymph nodes can be thoroughly extirpated, five year cures\* occur in about 30 per cent of cases, this is based on 18 per cent of five year cures when lymph nodes are involved and 48 per cent of five year cures when lymph nodes are not involved. Such facts, in contrast to the absolute hopelessness of the disease with any other method of treatment, constantly should emphasize the importance of developing every means for recognition of the disease while the growth still can be removed.

Accuracy in prognosis in disease is properly interpreted by the layman as an evidence of professional experience and knowledge. In cancer of the stomach, this is particularly true and whether or not the diseased tissue has been removed, relatives and friends can much more easily adjust themselves

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\* I have selected the five year period after operation as the time to estimate apparent cure for the reason that consideration of the charts will disclose the important fact that after five years, the death rate of those who have undergone gastric resection for carcinoma is approximately the same as that of the general population group of similar age and sex.

to the probable course of events, than to great uncertainty. When the condition is inoperable, any information which can be given as to the expectation of life, the nature of the symptoms which probably will mark the course of the disease, and what can be expected from the treatment of these symptoms, is most gratefully received. Similarly, in those cases in which the growth can be removed, or some palliative procedure can be carried out, the family should be informed of the facts on which prognosis is based and it is with a consideration of these facts that the remainder of this paper is concerned.

The findings to be reported here, as they are related to prognosis, are based on a series of 4,793 cases of gastric carcinoma in which operation was performed in The Mayo Clinic in the period 1906-1931. In 2,112 of these cases the growth could be removed either for palliation or in the hope of cure. This is a rate of operability of 45 per cent, based on the patients subjected to exploration, and of only 19 per cent, based on the number of patients concerning whom a diagnosis of cancer of the stomach was made. In 17 per cent, palliative gastro-enterostomy was done, and in 38 per cent, neither resection nor gastro-enterostomy seemed advisable (Table I). The expectation of life in the group in which exploration revealed the disease too advanced for either gastric resection or gastro-enterostomy was five months. In the group in which gastro-enterostomy was performed, the expectation of life was only one month more, or six months, and the mortality relative to the operation was 11 per cent.

TABLE I  
CARCINOMA OF STOMACH  
HOSPITAL MORTALITY FOR CERTAIN MAJOR OPERATIONS  
1906 TO 1931, INCLUSIVE

Operation	Number	Hospital Mortality Number	Per Cent
Partial gastrectomy	2,112	295	13.9
Gastro-enterostomy	833	96	11.5
Exploration	1,848	64	3.5
Totals	4,793	455	9.4

In the cases in which the growth was removed, the hospital mortality was 13.9 per cent (Table I). As is evident in Chart 1 the mortality seems to vary with the attitude of the surgeon toward the cases in which the disease is greatly advanced, for in some years the mortality has been as high as 23 per cent and in others as low as 8 per cent (120 cases with ten deaths). A low mortality is chiefly dependent on proper preparation of the patient for operation and meticulous attention to all those details which lessen the likelihood of development of the two chief causes of death in such cases, namely, peritonitis and pneumonia.

Many factors may be taken into consideration in estimating prognosis when the growth can be extirpated namely, the age of the patient, the duration of the symptoms, the gastric acidity, the size situation and extension of the lesion (into the serosa, lymph nodes, and so forth), and the pathologic characteristics. Although some of these factors proved to be of little significance, they are at least interesting and contribute to better knowledge of the basis of prognosis.

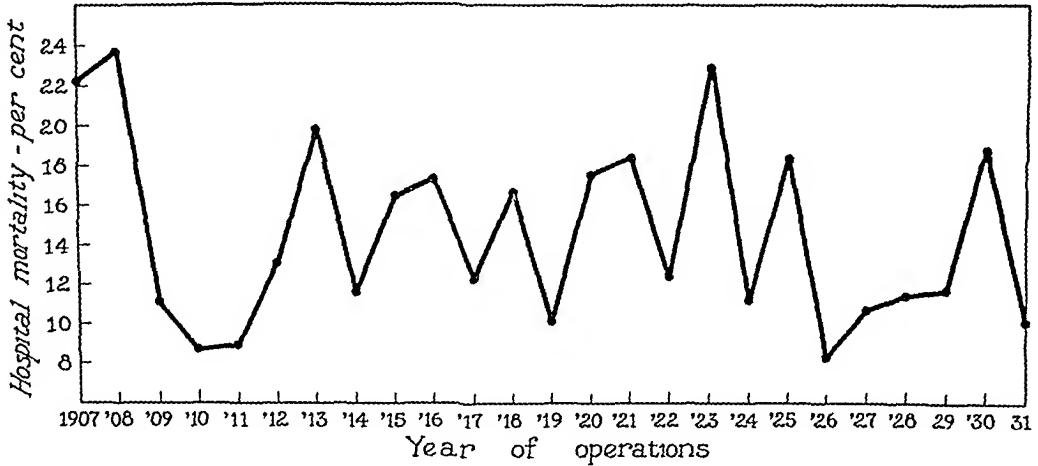


CHART 1—Hospital mortality in operations for gastric carcinoma (1907-1931)

In so far as age is concerned, it is shown in this series that the percentage of five year survival in the disease is higher among the older patients (33 per cent in the age group of 45-54 as contrasted with 25 per cent in the 35-44 group) (Chart 2)

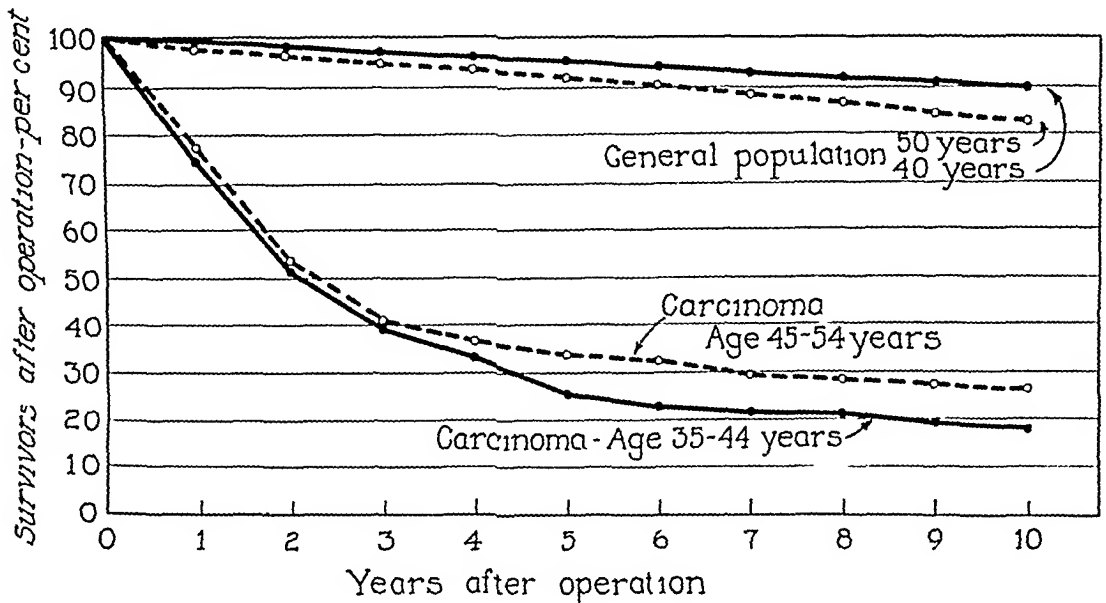


CHART 2—Significance of age in curability of gastric carcinoma

The length of history disclosed the interesting fact that five year survivals were more frequent among those cases in which gastric symptoms were of longer duration, for among those patients whose symptoms had been present for 12 months or more, 35 per cent lived five years while among those

whose symptoms had been present for six months or less, 25 per cent were alive and apparently well at the end of five years (Chart 3)

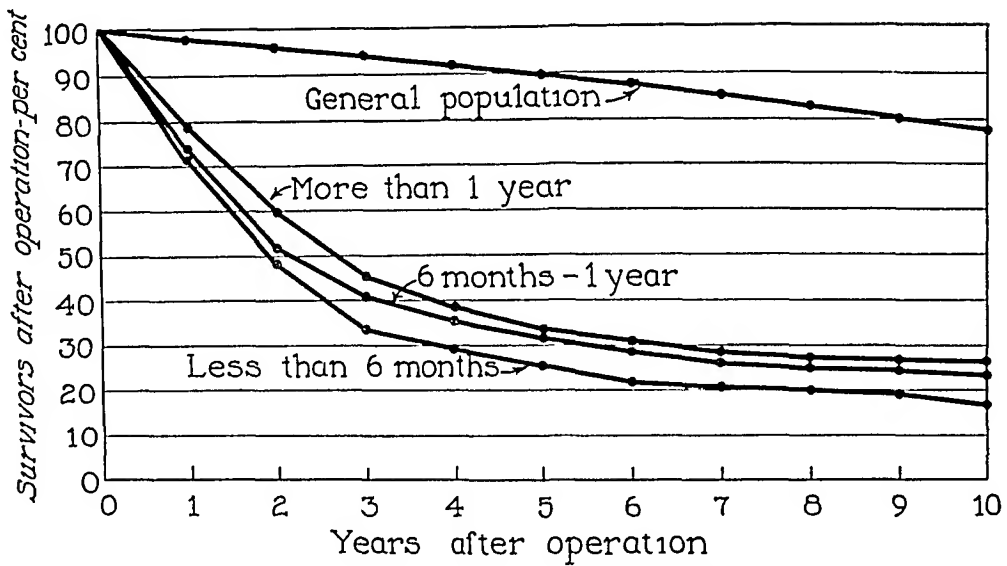


CHART 3—Significance of duration of symptoms in prognosis following gastric resection for carcinoma

In respect to the significance of secretory function of the stomach, I always had thought that the patient who had normal secretory activity would not have as good prospect of cure as one with less active function, yet this series shows the reverse, for among those patients whose secretory function was approximately normal, the five year survivals were 15 per cent more than among those whose secretory function was markedly diminished or absent (Chart 4)

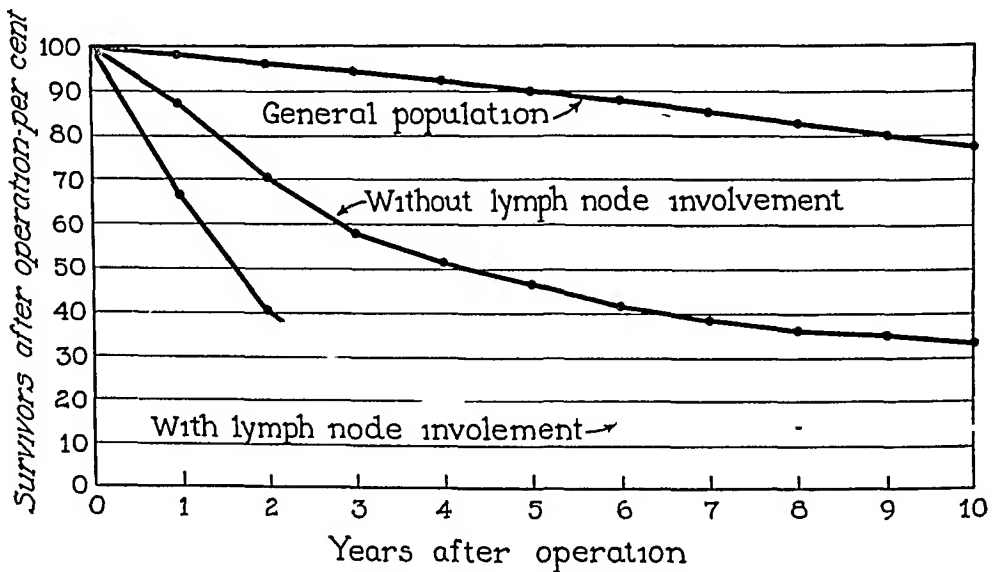


CHART 4—Significance of gastric acidity on postoperative results

Investigation of survival, based on the size of the lesion, disclosed the curious fact that there was greater expectation of life among patients who had the larger lesions than among those who had the smaller lesions. This

PROGNOSIS OF CANCER OF THE STOMACH

is probably attributable to the fact that the smaller lesions are more likely to be of a penetrating character and also of a higher degree of malignancy than the larger lesions. Survival of patients who had the larger (60 sq cm) lesions was compared with survival of patients who had the smaller

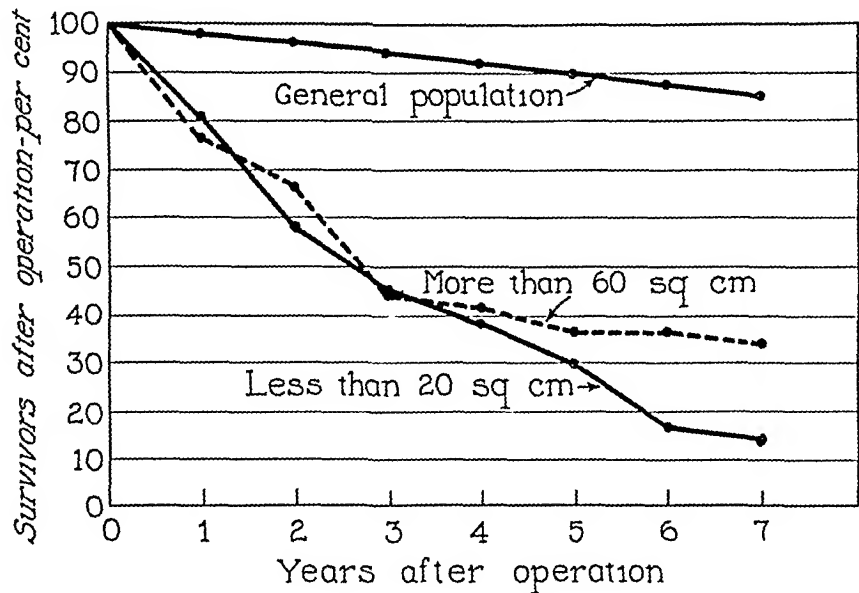


CHART 5—Influence of size of lesions on results of gastric resection for carcinoma

(20 sq cm) lesions, five years after operation, about 10 per cent more of the former than of the latter were living (Chart 5)

The situation of the lesion is of significance and in this series (Chart 6), the observation of others is confirmed, namely, that the nearer the lesion

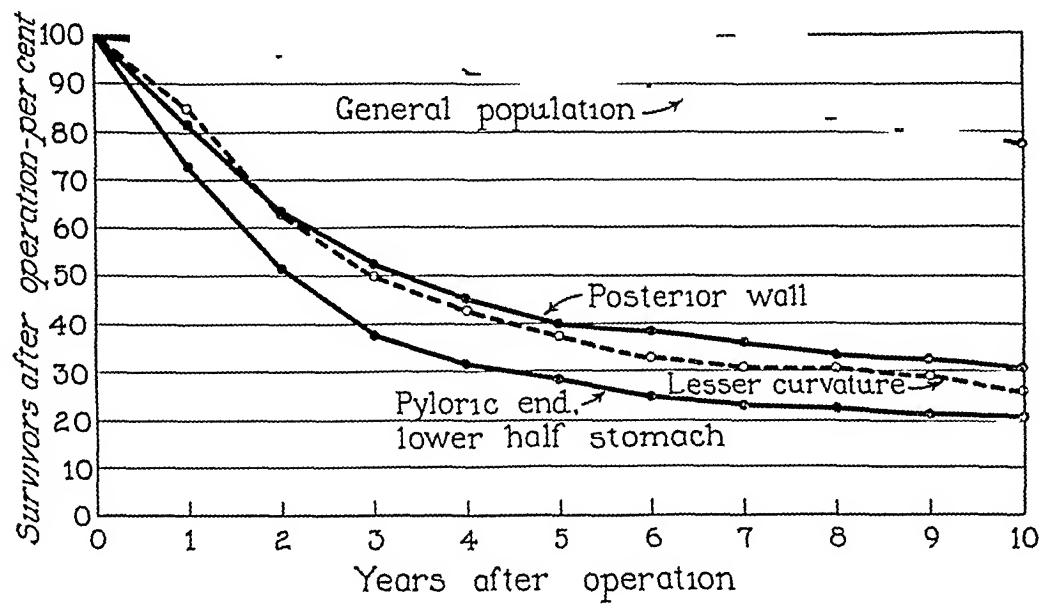


CHART 6—Significance of site of lesions on results following gastric resection

is to the pylorus, the more difficult it is to cure, and removable lesions in the body of the stomach are accompanied by a distinctly higher rate of survival than are those near, or involving, the pylorus (40 per cent compared to 28 per cent). This may be attributable to the fact that regional lymphatic

structures are more easily removed with thoroughness when they are in the former situation than in the latter, and also to the fact that not enough attention has been given to the importance of removing, in the resection, a segment of the first portion of the duodenum. It has been shown that although gross involvement of the duodenum is exceedingly rare in cases of cancer of the stomach, microscopic invasion not infrequently can be demonstrated.

The extension of the lesion has great significance in prognosis. Involvement of serosa was shown by Gray to decrease the possibility of cure by approximately the same per cent as involvement of lymph nodes which, as with cancer in all situations, lessens curability to a marked degree. Five years after operation for cancer of the stomach, as has been said earlier in this paper, 18 per cent of patients whose lymph nodes are involved and 48 per

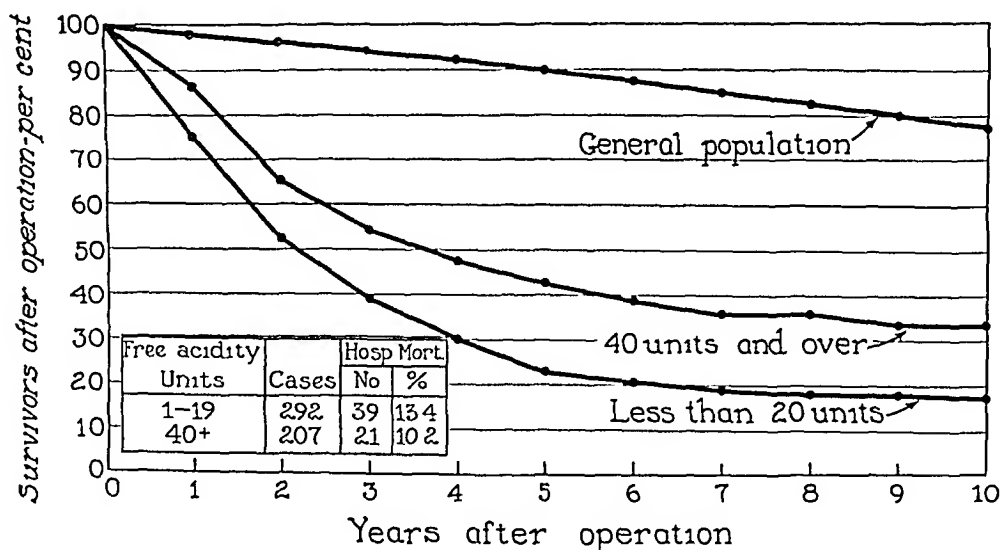


CHART 7—Significance of involvement of lymph nodes on curability of carcinoma

cent of those whose lymph nodes are not involved are alive. The difference then is 30 per cent (Chart 7).

The most accurate prognostic information obtainable in this series proved to be grading of malignancy by the method of Broders in which the degree of cellular differentiation is recorded as of Grades 1, 2, 3 and 4. Of patients whose carcinomata are of malignancy graded 1 and 2, 63 per cent are alive five years after operation, and ten years after operation 55 per cent of patients of this group are alive. These data can be contrasted with the fact that of patients whose carcinomata are of malignancy graded 3 and 4, only 20 per cent are alive five years after operation. These results again substantiate the fact that grading of malignancy stands first in importance in prognosis (Chart 8).

The coordination of these various factors has in our experience at the Clinic added definitely to accuracy in prognosis. This investigation also has supported the contention of surgeons that the surgical treatment of cancer



of the stomach can and does accomplish more than is recognized, and that constant repetition of this fact is the best approach to earlier recognition of the disease

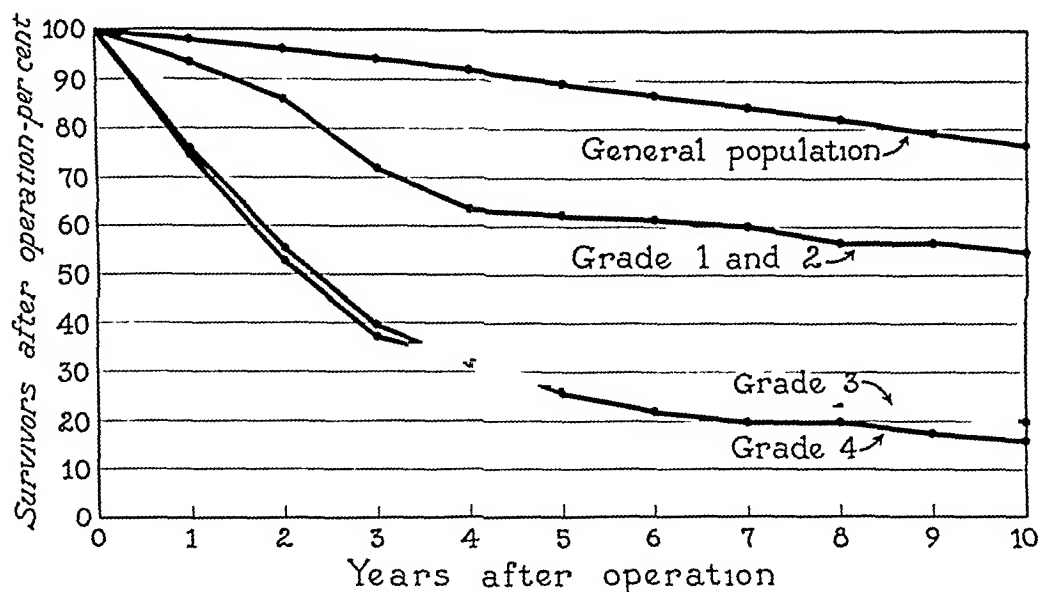


CHART 8—Significance of histologic grading (Brodens) on prognosis following gastric resection for carcinoma

DISCUSSION—DR J M T FINNEY (Baltimore, Md)—I wish to express my own personal satisfaction and am sure I speak for the entire group, when I thank Doctor Balfour for bringing out so graphically and clearly certain points that from his wealth of material he has been able to bring to the fore, and for emphasizing a number of other points of great practical importance

DR HAROLD L FOSS (Danville, Pa)—In discussing Doctor Balfour's paper may I approach the subject from a slightly different angle? In his experience at Rochester, 19 per cent of the patients were not in condition to be aided by any form of treatment. It is as important as ever to keep before the public the paramount necessity of early diagnosis in malignant disease. It is estimated, in Pennsylvania, that there are over 100,000 patients suffering from some form of neoplastic disease. The United States census bureau reports that 43 per cent of all Americans live in rural districts. Those who work in medical centers, serving rural sections, have found it to be true that rural patients invariably come much later for treatment than is the case with the patient of the metropolitan areas. In discussing a paper recently presented by Doctor Lahey covering some 200 cases of gastric carcinoma, I reviewed an equal number of my own. Doctor Lahey's patients came from a large metropolitan area, mine from the rural districts of central Pennsylvania. While 30 per cent of the city patients showed weight loss, 70 per cent from the rural sections had it as a chief symptom. Thirty per cent from the Boston area were vomiting, 70 per cent from the rural district. About 5 per cent of Doctor Lahey's patients had had hemorrhages, about 30 per cent of ours. In the patients coming from the city, 25 per cent were operable, in my series, but 5 per cent. In the inoperable group there was no operation whatever in 36 per cent of the urban cases, in the rural group, none in 57 per cent. In only 11 of the 200 rural patients was it possible to perform a resection. Fifteen per cent of all patients admitted

to our hospital have some form of neoplastic disease, nearly always in an advanced form. Our patients with carcinoma of the breast wait 15 months before seeking aid, those with carcinoma of the colon 11 months from the onset of the symptoms. Those with gastric carcinoma delay, on the average, eight months.

In our state, and I think this is typical of all states, there is a large group of sufferers destined to be treated far too late. In the rural districts these patients have not been so much in need of surgery as of education. Nearly 50,000,000 of our people live in the country and they are the ones not being reached by the groups trying to do the things Doctor Balfour says are so important. As was stated in the paper, surgery of the stomach has probably reached as high a degree of technical perfection as is possible and it is not likely that much greater progress will be made by the roentgenologists or diagnosticians in their fields. More can be accomplished only if we can aid these agencies in the education of those people who are likely to develop cancer, or who have it, and who know nothing about the disease. I recently had as a patient the director of the Public Works Administration for Pennsylvania. He informs me that in our state the W P A is spending over \$20,000,000 a month—on roads and airports and bridges, *etc*. I asked what was being done regarding lay education on medical matters and he told me “nothing.”

The mortality of cancer will not be decreased, and surely the operability of cancer of the stomach will not be increased, until patients can be seen far earlier. While the Society for the Control of Cancer, the American College of Surgeons, cancer commissions and other groups are, to a certain extent, reaching the patient of the larger medical centers, patients constituting nearly 50 per cent of our American population, those living in the rural sections, know nothing of this program of education or of the need for it.

Four billions of Federal money is being spent on all sorts of projects, most of them, no doubt, meritorious. Why not take 25 millions of this, say but one month of Pennsylvania's allotment, for lay education dealing with the menace of malignant disease, its prevention and early eradication, especially lay education among our rural patients? No one could doubt but that thousands of lives would be saved and incalculable suffering prevented.

# CHRONIC OBSTRUCTION AND DILATATION OF THE DUODENUM

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SINCE the report of Bloodgood,<sup>2</sup> in 1907, of a case of chronic dilatation of the duodenum, considerable interest and much controversy have been aroused over the significance of the dilated duodenum and the question as to whether in the condition designated "chronic duodenal ileus" we have a true pathologic and clinical entity. Balfour,<sup>1</sup> Bloodgood,<sup>3</sup> Duval, Roux and Beclere,<sup>6</sup> Halperit,<sup>7</sup> Kellogg and Kellogg,<sup>10</sup> Staveland,<sup>14</sup> Wilkie<sup>16</sup> and others have reported clinical and pathologic observations supporting the conception that chronic duodenal obstruction is a definite pathologic and clinical entity and amenable to surgical treatment.

In recent years there has been considerable controversy as to the value of surgery and it has been said, "As time passes, the superior mesenteric artery pressure theory will fade until it disappears altogether from our horizon."<sup>13</sup>

That other forms of dilatation of the duodenum occur is more than probable and is no argument against the existence of the one with which we deal here.

Imperfect rotation of the colon in fetal life, which brings the superior mesenteric vessels to lie across the duodenum, and imperfect fixation of the colon are found most frequently in asthenic and viscerotonic types, and it is in this class of individuals that duodenal ileus is most frequently encountered.

The tolerance of the small intestine to partial interference with the onward progress of its fluid contents is well known and it is easily conceivable that a partial duodenal obstruction may exist for years without symptoms sufficiently pronounced to recognize the lesion clinically until, finally, a complete obstruction supervenes with symptoms too obvious to be overlooked.

The reported results vary with different surgeons. Some report excellent results<sup>9</sup> but surveys by others show complete cures in only about 50 per cent of the cases.<sup>8, 11, 12, 17</sup>

It is our opinion that the reported poor results are the results of the application of sound surgical principles in the absence of a definite obstructing mechanism.

The evidence submitted in the following case report sustains the conception of chronic duodenal obstruction as a clinical entity amenable to surgical treatment.

**Case Report**—G W, white, female, age 18, complained of nausea and vomiting for six weeks. In the beginning the complaint was characterized by nausea only. After a few days vomiting ensued. The vomitus was described as bilious—large quantities of bile-stained fluid. Confinement to bed and liquid diet gave a measure of relief for ten days and then she began vomiting everything taken into her stomach. At times food taken 24 hours previously was noted. At no time during these six weeks had she suffered pain.

The past history is of great interest and perhaps significant. At three weeks of age, because of persistent vomiting, she was taken to the late Doctor Tuholske of St. Louis, whose diagnosis was "pylorospasm" and whose treatment consisted of stomach washings and forced feeding by means of a tube for a period of six weeks. At the end of this time, her condition being improved, she was put back on the breast and did fairly well, with the exception of occasional spells of vomiting, until her second summer, when she suffered from "colitis" for eight weeks. This attack of colitis was characterized by much vomiting and alternating constipation and diarrhea. At six years of age she was sick for a year and lost much weight because of frequent attacks of nausea and vomiting. The vomitus consisted of bile-stained fluid and food particles. During this sixth year of life numerous and varied examinations by many physicians resulted in no definite diagnosis. For the past 11 years she has had no definite attacks of vomiting, but, as her mother describes her condition, "She has been a poor eater, many foods disagreeing with her, producing a sense of fullness and much belching." The gaseous eructations have been a source of great embarrassment to her. All her life she has been undernourished and frail and a source of anxiety to her parents.

This is a fairly accurate history of the patient until the onset of the present complaint some six weeks previous to her admission to the hospital.

*Physical Examination*—Patient is an asthenic, viscerotropic young woman, five feet, two inches in height, weighing 98 pounds, with a normal temperature, pulse 70, blood pressure 95/70. The heart and lungs are normal. The abdomen is flat, muscles flaccid, and there is tenderness over Mayo-Robson's point. There is marked ptosis of the right kidney. Pelvic examination reveals a retroverted uterus. Examinations of blood and urine were reported normal. Basal metabolic rate + 13.

*Roentgenologic Examination*—(Dr. William D. Anderson)—Fluoroscopy. The lungs appear normal. The heart is small and in the midline. The breathing is costal in type and expansion is about equal on the two sides. There is moderate scoliosis of the dorsal spine with convexity to the left and compensatory scoliosis of the lumbar spine with convexity to the right. There is tilting of the pelvis to the right. The esophagus is normal. The cardiac orifice is normal. The stomach is the long fish-hook type and when filled, extends well down below the brim of the pelvis, the greater curvature reaching a line joining the lower ends of the two sacro-iliac joints. There is a moderate amount of fluid and mucus present in the fasting stomach and the barium meal can be seen falling through this supernatant layer of fluid. The tone of the stomach is extremely poor. Peristalsis is almost entirely absent, only an occasional wave of slight depth being noted. Mobility of the stomach is normal. Motility is slow. The pylorus is patent and shows no spasm. There is no evidence of defect or niche in the gastric outline. The gastric rugae are easily brought out but are not increased in size. The duodenal cap fills out well, is triangular in outline and shows no evidence of defect or spasm. There is no irritability. The second portion of the duodenum is dilated, with increase in the rugal markings and an extreme writhing and to-and-fro motion of the barium meal. About three inches from the cap the meal meets an obstruction, producing the dilatation and past which the meal cannot actually be seen to pass, although small amounts of barium are passing, as it can be seen farther down in the jejunum. In the prone position with the patient turned slightly to the right, this dilated portion of the duodenum appears flattened as if by pressure of an enlarged or

ptosed liver. When the patient is turned slightly to the left, this flattened appearance disappears. The definite cause of the obstruction cannot be determined under the fluoroscope.

**Roentgenography—Immediate—Vertical Position** shows the body of the stomach well down in the pelvis, as seen on fluoroscopy. The stomach is dilated and atonic. The barium meal puddles in the dependent portion. Traces of barium may be seen adhering to the mucosa of the prepyloric region, the duodenal cap and the proximal part of the second portion of the duodenum. There is some barium collected in the distal end of the second portion of the duodenum at the apparent point of obstruction. **Horizontal position, patient on back,** shows the body and cardiac end of the stomach filled and dilated but otherwise normal. Traces of barium in the prepyloric region and cap. **Prone Position** Stomach is well filled and still atonic. No evidence of defect or niche in the gastric outline. Duodenal cap well filled and normally outlined. The second portion of the duodenum is filled and dilated for a distance of about four inches beyond the cap, and is flattened on the right side due to pressure on the liver, which



FIG. 1—Roentgenogram before operation showing the dilated and obstructed first and second portions of the duodenum to the right of the midline.



FIG. 2—Appearance of the stomach and duodenum at the end of six hours showing the gastric and duodenal retention.

is very low, extending four fingers' breadth below the costal margin. Traces of barium may be seen in the third portion of the duodenum (Fig. 1).

**Two and one-half hours**—The stomach is still half full and shows no better tone than on previous film.

**Five hours**—The stomach is approximately one-third full. Duodenum is still dilated and filled with barium to the distal part of the second portion.

**Six hours**—The stomach is about one-fourth full. The duodenum does not show as much dilatation at this time as before. However, there is still barium present in the second portion, which ends abruptly at a point about four inches from the cap. Traces of barium are seen in the third portion, which does not appear to be dilated. Barium is scattered throughout the remainder of the small intestine, which appears normal, except for the extreme ptosis (Fig. 2).

**Twenty-four hours**—Patient vomited since last observation. No barium in stomach or upper intestine. There is irregularly scattered barium throughout the colon which is not filled well enough for accurate study. There is some barium in the terminal ileum. The appendix cannot be definitely visualized.

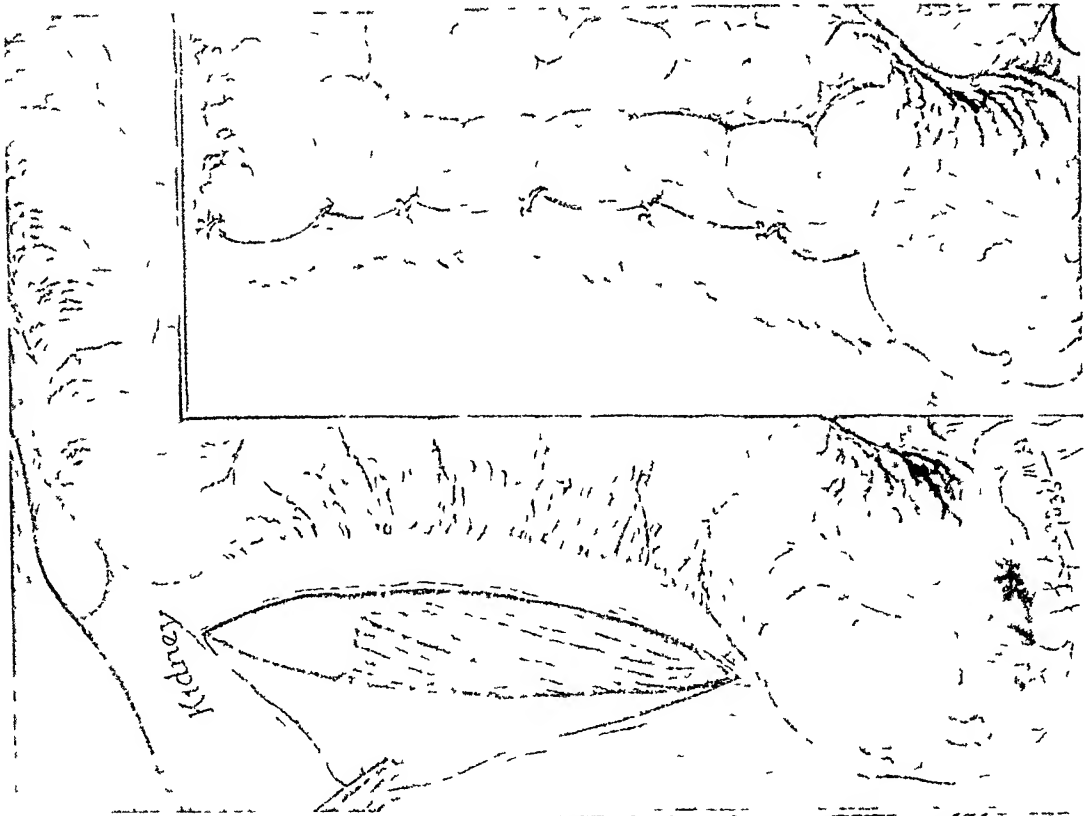


FIG 5.—Mobile colon with its mesentery and Wauich colopexy

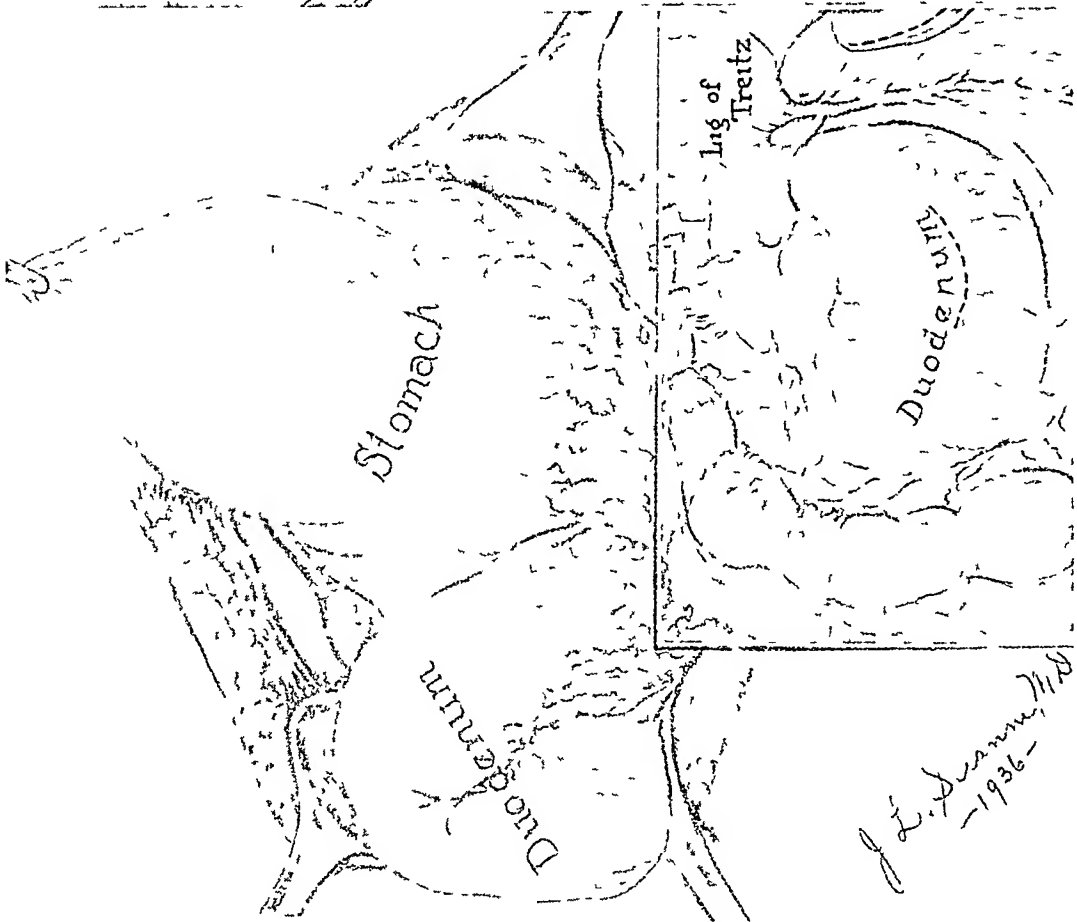


FIG 3.—The dilated stomach and mobile duodenum with marked dilatation of the first and second portions (Insert) Dilated third portion of the duodenum shining through transverse mesocolon Dilatation limited at point of crossing of superior mesenteric vessels and diaphragm of mesocolon The small empty jejunum

Roentgenologic Diagnosis—(1) Chronic partial duodenal obstruction with dilatation, the point of obstruction being apparently four or five inches distal to the pylorus (2) Dilatation and atony of the stomach (3) Generalized visceroptosis, extreme degree (4) Scoliosis of the spine

*Operation*—On December 2, 1935, with the preoperative diagnosis of chronic duodenal obstruction with dilatation, the patient was subjected to operation. Under ether anesthesia, through a right rectus incision, the following gross findings were revealed (Fig 3). The stomach dilated, walls thin, pylorus patulous, admitting two fingers. The duodenum mobile, attached by a mesentery, the first and second portions dilated to three times the normal size. On raising the transverse mesocolon, the greatly dilated third portion of the duodenum was seen bulging through the transverse mesocolon. This dilatation of the duodenum extended to the point of crossing of the superior mesenteric artery but at this same point there was also considerable drag of

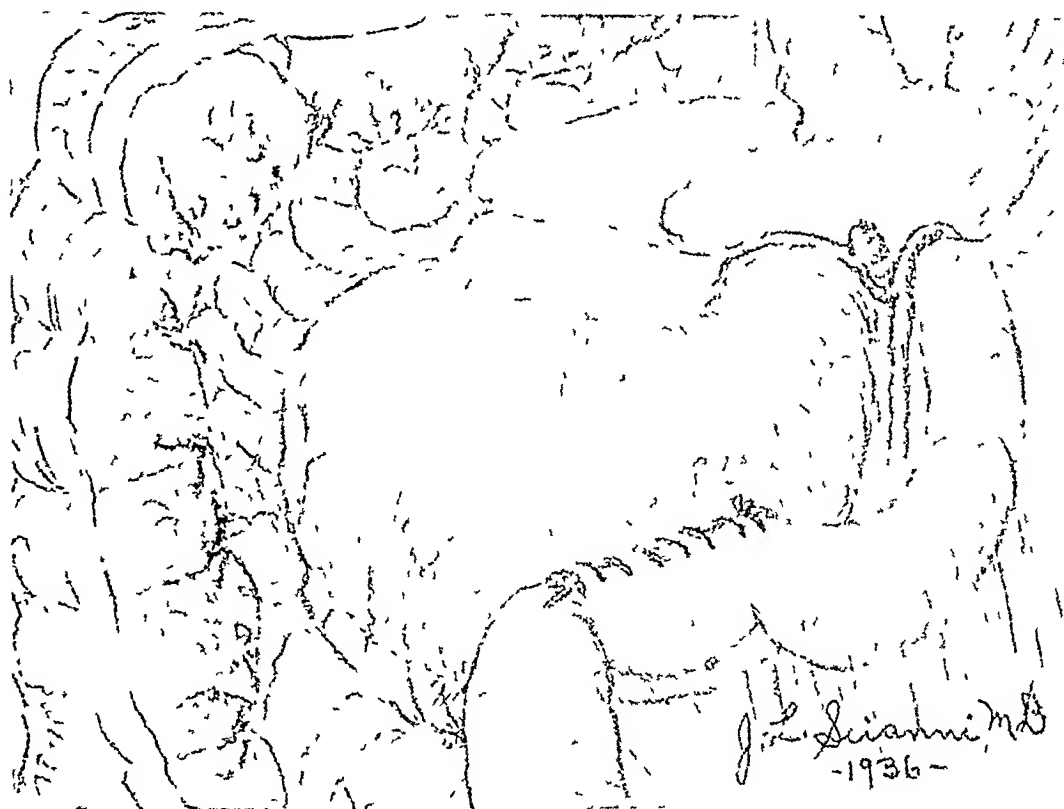


FIG 4—Submesocolic duodenojejunostomy

the mesocolon, which was relieved by lifting up a mobile colon. The jejunum was empty and smaller than normal by one-half the normal circumference. On pulling up the mesentery, the distended third portion was seen to empty into the jejunum, filling it. The ascending colon was mobile, attached by a mesentery. It could be lifted out of the abdominal cavity. The appendix was normal. The right kidney was ptosed. The uterus was retroverted. The liver was low, extending four fingers' breadth below the costal arch. The gallbladder was normal.

A submesocolic duodenojejunostomy (Fig 4) was performed, by the clamp method, between the dilated third portion and the jejunum, the mesocolic opening being between the superior mesenteric artery and the right colic artery, also an appendectomy, and a colectomy, after the technic of Waugh<sup>15</sup> (Fig 5).

The patient made an uninterrupted recovery and on the fifth postoperative day was taking a light diet and enjoying it. She was discharged on the twelfth postoperative day, at which time she was taking a liberal diet, with no digestive complaint.

One year has passed since this operation was performed. The patient has been

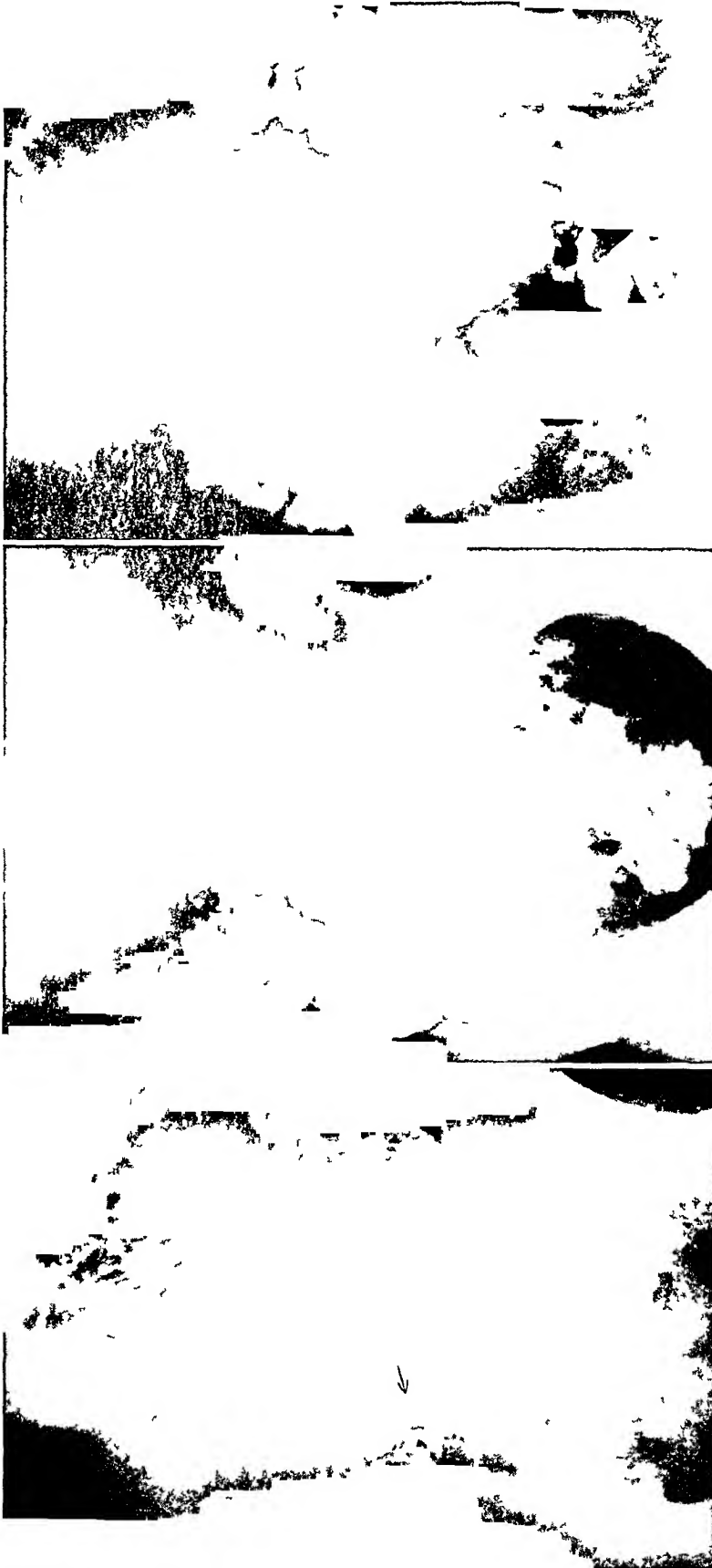


FIG 6.—The stomach and duodenum one month after operation. The arrows indicate the passage of barium through the operative opening between the third portion of the duodenum and jejunum

FIG 7.—Six hour roentgenogram one month after operation. Note that stomach is completely empty and barium meal is now in the colon and terminal ileum

FIG 9.—Twenty four hour roentgenogram one month after operation. The colon is well filled and only slightly prolapsed



well. She reports that she has had no indigestion, her weight is 106 pounds, and she has completed another year of college work, participating in all college activities.

**COMMENT**—The very definite roentgenologic findings of duodenal obstruction and dilatation, on which the preoperative diagnosis was made, may be seen readily in Figs 1 and 2. These two findings, together with the writhing motion proximal to the obstruction, noted on fluoroscopic examination, and the delayed emptying of the stomach and duodenum, complete the characteristic roentgenographic picture of chronic duodenal obstruction.<sup>4</sup>

The point of obstruction was demonstrated roentgenologically to be in the lower, second portion of the duodenum. This corresponded to the operative finding of mesocolic duodenal compression by the middle colic artery and explains why the obstruction, by compression from the superior mesenteric artery, was not visualized.

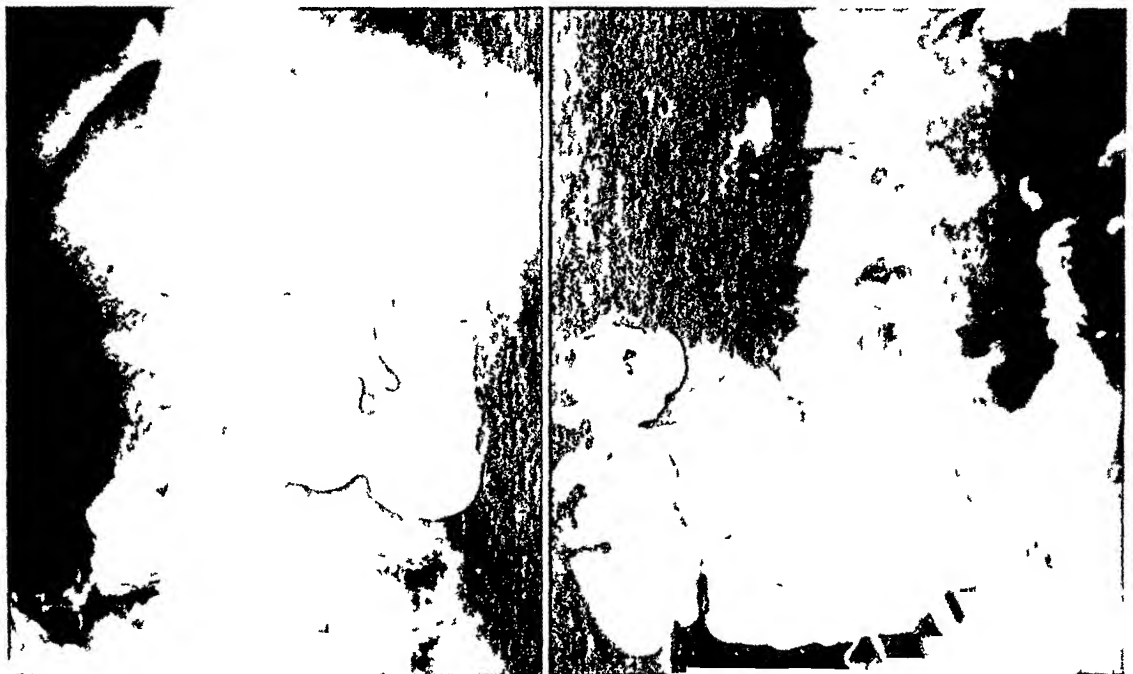


FIG 9—Roentgenogram of stomach and duodenum one year after operation, showing good emptying.

FIG 10—Six hour roentgenogram one year after operation. The stomach and duodenum are practically empty at this time.

A second series of roentgenologic studies was made one month after operation. This clearly demonstrated the restoration of normal function. The duodenojejunostomy is well depicted in Fig 6. The stomach and duodenum are completely empty at the end of the six hour period (Fig 7). At the end of 24 hours the colon is well filled and only slightly prolapsed (Fig 8).

A check up roentgenologic examination at the end of one year post-operatively reveals the stomach and duodenum still emptying freely (Fig 9). The slight gastric residue noted on the six hour film (Fig 10) is probably explained by the composition of the barium meal—milk and barium instead of water and barium, as used in the two former examinations.

The findings in this case demonstrate that the obstruction of the duo-

denum was due to a combination of two factors, namely, arteriomesenteric and arteriomesocolic strain. "The conception of the anatomical conditions underlying the arteriomesenteric and the arteriomesocolic occlusion of the duodenum may or may not be a pure academic discussion."<sup>5</sup> The findings in this case were very definite. The clinical history and the operative findings strongly support the theory that the obstructing mechanism was present from birth—the result of a developmental defect, an imperfect rotation and fixation of the colon—and that its presence was more or less manifest throughout the 18 years of this patient's life. The history, the clinical findings, the roentgenologic observations and the gross findings at operation definitely stamp it as a clinical entity, readily diagnosed.

The dogmatic negation of the "superior mesenteric artery pressure" theory and the substitution therefore of the indefinite terms "neurosis"<sup>5</sup> or "neuromuscular derangement"<sup>11</sup> are not conducive to sound thinking and are not in accord with authenticated clinical observations or clinical end-results.

The operative procedure of duodenojejunostomy supplemented by a Waugh colectomy fulfilled the mechanical indications for relief in this case. That this relief has been realized is evidenced by the restoration of this patient to a normal life.

#### CONCLUSIONS

(1) Chronic duodenal obstruction with dilatation of the arteriomesenteric type does exist as a clinicopathologic entity.

(2) It is of congenital origin, resulting from the developmental defect of improper rotation of and fixation of the colon.

(3) It can be positively diagnosed by a careful consideration of the history, the physical examination and roentgenologic examination.

(4) The operation of duodenojejunostomy combined with colectomy, after the technic of Waugh, fulfills the surgical indications for relief.

#### REFERENCES

- <sup>1</sup> Balfour, D. C., and Gray, H. K. Duodenal Ileus. Congenital Deformity of the Duodenum. *Surg Clin N Amer*, 12, 862, 1932.
- <sup>2</sup> Bloodgood, J. C. Acute Dilatation of the Stomach—Gastro-mesenteric Ileus. *ANNALS OF SURGERY*, 46, 736, 1907.
- <sup>3</sup> Bloodgood, J. C. Dilatation of the Duodenum in Relation to Surgery of the Stomach and Colon. *JAMA*, 59, 117, 1912.
- <sup>4</sup> Carman, Russel D., and Miller, Albert. Roentgen Diagnosis of Diseases of the Alimentary Canal. W. B. Saunders & Co., 1917.
- <sup>5</sup> Devine, H. B. Basic Principles and Supreme Difficulties in Gastric Surgery. *Surg, Gynec & Obstet*, 41, 688, 1925.
- <sup>6</sup> Duval, Roux and Beclere. The Duodenum. Medical, Radiologic and Surgical Studies (Translated by Quain). C. V. Mosby Co., 1928.
- <sup>7</sup> Halpert, Bela. The Arteriomesenteric Occlusion of the Duodenum, an Anatomical Study. *Bull Johns Hopkins Hosp*, 38, 409, 1926.
- <sup>8</sup> Higgins, C. C. Chronic Duodenal Ileus with Report of 56 Cases. *Arch Surg*, 13, 1, 1926.

- <sup>9</sup> Judd, E S, and Puestow, C B    Chronic Duodenal Obstruction    Surg Clin N Amer, 13, 807, 1933
- <sup>10</sup> Kellogg, E L, and Kellogg, W A    Chronic Duodenal Obstruction with Duodeno-jejunostomy as a Method of Treatment, Report of 41 Operations    ANNALS OF SURGERY, 73, 578, 1921
- <sup>11</sup> McKenty, James    Chronic Duodenal Stenosis    Surg, Gynec & Obstet, 38, 444, 1924
- <sup>12</sup> Quain, E P    Chronic Duodenal Obstruction    Etiology, Symptoms and Treatment    Lancet, 42, 575, 1922
- <sup>13</sup> Robertson, George    Acute Dilatation of the Stomach and Intestinal Tube with Consideration of "Chronic Duodenal Ileus"    Surg, Gynec & Obstet, 40, 206, 1925
- <sup>14</sup> Stavely, A L    Acute and Chronic Gastro-mesenteric Ileus with Cure in a Chronic Case by Duodeno-jejunostomy    Bull Johns Hopkins Hosp, 19, 252, 1908
- <sup>15</sup> Waugh, George E    The Morbid Consequences of a Mobile Ascending Colon, with a Record of 180 Operations    Brit Jour Surg, 17, 343, 1920
- <sup>16</sup> Wilkie, D P D    Chronic Duodenal Ileus    Brit Jour Surg, 9, 204, 1921-1922
- <sup>17</sup> Wilkie, D P D    Chronic Duodenal Ileus    Amer Jour Med Sc, 173, 643, 1927

# THE TECHNIC OF CLOSING PERFORATED ULCER OF THE DUODENUM

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IT IS evident that writers on the treatment of perforated duodenal ulcer have found its closure difficult and liable to leak or obstruct the duodenum. They speak of sutures cutting through the friable edges of the ulcer, and of the impossibility of closing large ulcers, which must be drained or provided with a precarious covering of gallbladder or omentum. Deaver<sup>1</sup> is the only writer I have found who states without qualification that all perforations can be closed by suture. Rather significantly, he advocates gastro-enterostomy in all cases. Guthrie and Shaver,<sup>2</sup> in a recent article, report the use of a row of through-and-through sutures of catgut, reinforced by a second row of catgut sutures or a purse-string suture of silk. They must have observed that this method of closure often narrowed the lumen of the duodenum, for they remark that "it is surprising how much the duodenal lumen may be encroached on without producing obstructive symptoms." Keil<sup>3</sup> advocates closure with a continuous suture placed at right angles to the long axis of the bowel to minimize obstruction. In practically every discussion of this subject in text-books or elsewhere, the probability of duodenal obstruction seems to be foremost in the mind of the author. This explains the almost endless controversy over whether gastro-enterostomy or pyloroplasty should be performed after closure of the perforation. Perhaps the best summary of current methods of treatment, as well as the best conception of the possible difficulties and complications of the closure, is contained in the following advice by Moynihan,<sup>4</sup> published in 1928: "In duodenal ulcers, where the rent is small and surrounding induration absent or of very limited extent, closure of the perforation is all that is required.

"In duodenal ulcer where the rent is larger and induration more extensive, one of the two courses may be followed: (a) The ulcer may be infolded and gastro-enterostomy or gastroduodenostomy performed or (b) The rent may be enlarged, the ulcer excised, and a plastic operation which secures an enlargement of the passage from the stomach may be performed.

"In duodenal ulcer where the gap is very large and induration extensive, one of the two courses may be followed: (a) The ulcer may be closed as much as possible, and the gap filled by a plug of omentum, gastro-enterostomy being performed or (b) The opening may be used for the performance of temporary duodenostomy. Both methods are unsatisfactory, and are only to be used in an emergency."

It would seem that a method which does away with most of these difficulties and complications is worthy of trial. The authors have used the technic herein described for about 10 years. It provides a leak-proof and

nonoccluding closure of even the largest perforations. It can be easily and quickly performed.

*Operative Technique*—A good incision, which has been previously described by others and which permits of a good exposure of the duodenum and gives a firm wound, begins at the right costal border about two inches from the midline, and extends vertically downward for about five inches. The structures of the abdominal wall, down to the aponeurosis of the transversalis muscle, are divided in the line of incision, and then retracted so as to give a wide exposure of this aponeurosis, which is now penetrated by separation instead of division of its fibers. Since this is the strongest layer of the abdominal wall, failure to close it securely predisposes to evisceration and hernia. It cannot be closed satisfactorily if its fibers are cut, because sutures pull out between the ends of the severed fibers. This incision is easily closed and makes dehiscence of the wound almost impossible, even if it becomes infected.

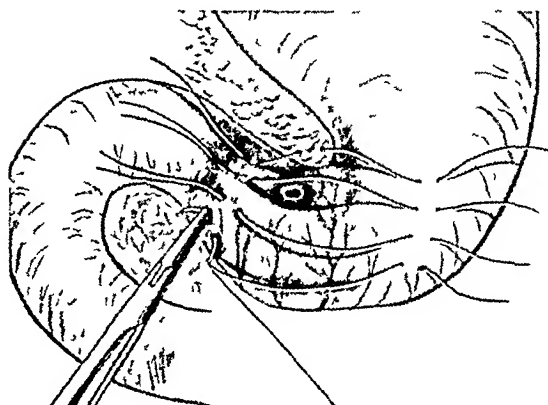


FIG 1—Showing the insertion of the sutures into the stomach and duodenum

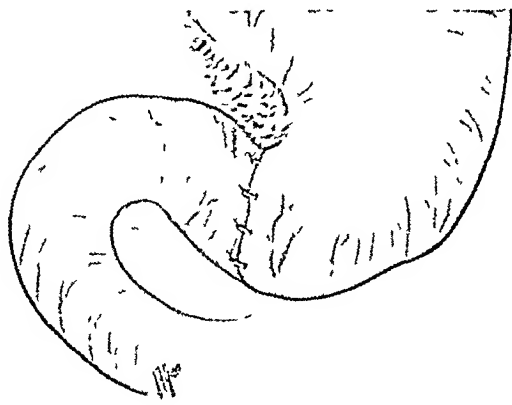


FIG 2—Showing the appearance after the sutures have been tied

The edges of the wound are retracted, and the gastric contents removed from the peritoneal cavity by thorough and systematic aspiration, done as far as possible under direct guidance of the eye. Sponging is not used. The duodenum is now exposed and the perforation located. In our experience, it has been situated almost always near the pyloric sphincter and on the anterosuperior surface of the duodenum. It is always surrounded by a zone of friable tissue, which affords a very unsafe hold for sutures.

Several silk sutures, which pick up the stomach wall about one to two inches from the pylorus, and the duodenal wall, distal to the ulcer, where they can obtain a firm hold, are now inserted, but not tied until all have been placed. These are so placed that when tied they will pull the anterior surface of the stomach over the perforation and close it completely without tension on the sutures (Figs 1 and 2). The suture line is strengthened where necessary with additional sutures, and then covered completely with omentum, which is sewed in place.

When we first began to use this method, we wondered if it were applicable to the closure of perforations in large calloused ulcers involving the

near and left lateral surface of the bulb. Experience however, has shown that these perforations can be easily closed by it, better, I think, than in any other way. If the posterior surface of the bulb above the ulcer is freed, then the sutures can be passed through healthy duodenal tissue, and when tied will pull the stomach wall securely around and over the perforation. The closure can be made more secure by passing the uppermost suture through the gastrophatic omentum as this suture passes from stomach to duodenum.

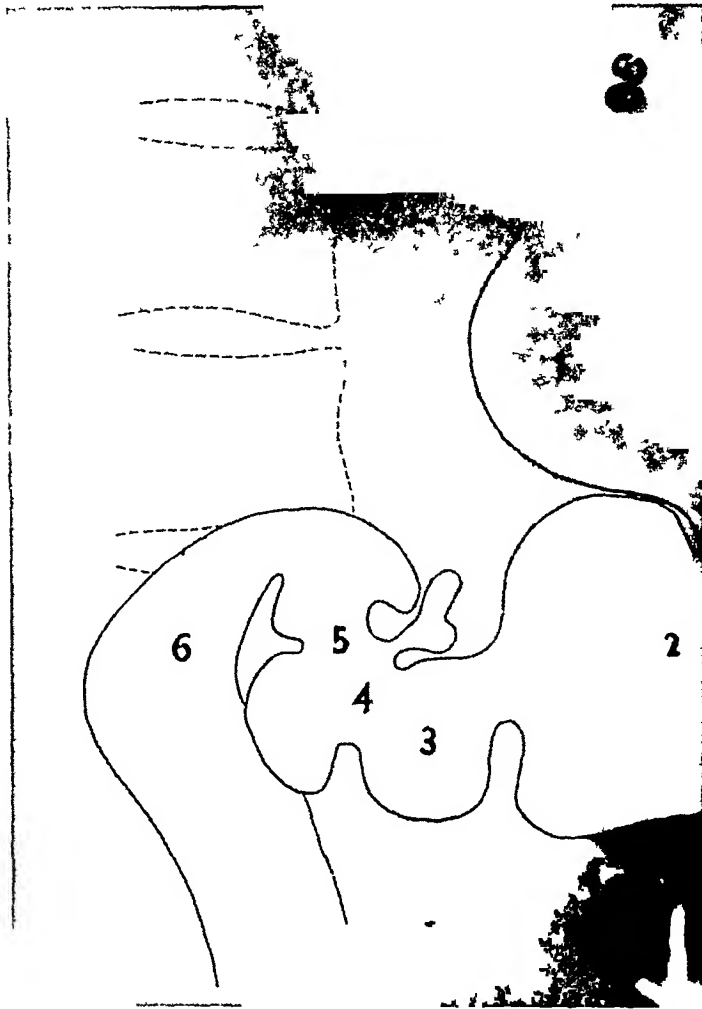


FIG. 3.—Outlined roentgenogram showing the nature of the deformity resulting from the procedure suggested. Note absence of obstructions and of any pinching of the prepyloric part of the stomach. (1) Cardia. (2) Fundus. (3) Pylorus. (4) Pyloric sphincter. (5) Deformed duodenal bulb. (6) Second portion of duodenal bulb.

The superior edges of the duodenal bulb and prepyloric part of the stomach form in most cases a somewhat acute angle with its apex at the upper margin of the pylorus. The anterosuperior surfaces of these parts are not far distant from one another. They can therefore usually be sutured together without much tension.

For a while we feared that the operation would produce a pouch of stomach wall above the pyloric sphincter in which food might stagnate. Roent-

genologic studies, however, have shown this fear to be groundless, and that any pouching of the stomach wall which may be present is too slight to cause dysfunction

It is a great merit of the operation that it makes unnecessary, in nearly all cases, the performance of gastro-enterostomy or pyloroplasty in addition to closure of the perforation. If the ulcer is not calloused, and is already causing some obstruction, this will seldom be so nearly complete as to prevent the recovery of the patient from his peritonitis, and his survival until the operative relief of his obstruction can be undertaken with comparative safety.

This statement is especially true since the introduction, as a routine post-operative treatment, of continuous gastric lavage and the intravenous administration of sufficient salt solution and glucose.

If, despite expectations to the contrary, the obstruction does prove complete, then the patient, if he recovers from his peritonitis, can be fed until his nutrition is excellent through a Witzel jejunostomy performed under local anesthesia. I have often treated patients in poor condition because of pyloric obstruction in this way, and have fed two patients having a perforated duodenal ulcer similarly. It is to be noted that a patient with complete obstruction because of a calloused ulcer would already, at the time of operation, be in a bad state of nutrition, and not a good subject for more than the minimal amount of surgery.

Though we have spoken with some enthusiasm of this method of closing perforated duodenal ulcers, we do not claim that all of them can be closed by it. We have found it efficient for all perforations except those complicated by an abscess over the duodenum. This is found when the perforation, of long standing, has leaked so slowly that the escaping duodenal contents have been confined by peritoneal adhesions to the neighborhood of the perforation, or to the surrounding region, including the subphrenic space, without contaminating the entire abdominal cavity. Under these circumstances the duodenum will be seminecrotic, and covered all over by a thick, decomposing, fibrinous exudate, which hides it and the perforation from sight. There is probably no method whereby a perforation can be closed effectively in the presence of this complication. I have encountered it on three occasions. Two of the patients, in desperate condition at the time of operation, died. For all three nothing more than drainage was attempted.\*

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\* The patient who recovered was given salt solution and glucose by vein for the first nine days. After that he was fed through a Witzel jejunostomy till his duodenal fistula closed. This was treated by continuous suction. It healed in about two weeks without noteworthy digestion of the wound. He was dismissed 33 days after admission. At that time a barium meal showed normal emptying of the stomach. Five years later, however, he returned because of complete pyloric obstruction. This was relieved by pyloroplasty. At operation a diverticulum two and one-half inches long and one and one-half inches in diameter arising from the upper surface of the first part of the duodenum was found. We attributed this to the unclosed perforation. It was excised and a modified Finney pyloroplasty performed. The patient has now remained well for two years.

*Results*—We have closed 26 duodenal perforations by the method just described. The average age of the patients was 40 years, the limits being 20 and 72 years. All were men. Six patients had drains inserted through incisions in the right flank and suprapubic region. Five of these died. Of the 20 patients whose abdomens were closed without drainage, none died. Two of them had some infection of the wound. One of these developed an incisional hernia.

Twenty-one patients recovered, five died, a mortality of 19.6 per cent. Of 18 patients operated upon sooner than 11 hours after perforation, none died. Of 21 patients operated upon sooner than 24 hours after perforation, only two died, a mortality of 9.5 per cent. Of four patients operated upon 24 hours or longer after perforation, only one recovered. These results, compared with results reported by others who used various operative procedures, demonstrate that the immediate prognosis depends more on the time elapsed since perforation than on the special operative procedure employed. This statement, however, is not true of the late results.

We have been able to trace all 20 of the patients who recovered. Two have died, one of tuberculosis, and one following operation for stone in the common bile duct. This was the only patient who had gallstones. To date, only one of them has required a gastro-enterostomy for duodenal obstruction. The others have remained as nearly free of indigestion as you can with reason expect patients of the ulcer type to remain. Their ulcers have apparently been cured by the perforation. In none of them has duodenal obstruction been caused or increased by the operation, and in all but one, whatever obstruction was present at operation has either disappeared, or has not increased enough to cause symptoms.

#### CONCLUSIONS

(1) Perforated ulcer of the duodenum can be closed easily and securely by suturing the prepyloric surface of the stomach to the healthy duodenal wall, above, under, and distal to the perforation.

(2) This procedure does not cause, under any conditions, duodenal or pyloric obstruction, and does not increase any obstruction already existing.

(3) Roentgenologic studies show the apparent cure of ulcers so treated, no stasis of stomach contents in the prepyloric region and no delay in their passage through pylorus and duodenum.

(4) None of the five deaths following operation could be attributed to this method of closing the perforation.

(5) The late results of the operation have been excellent. They prove that pyloroplasty or gastro-enterostomy are seldom necessary when it has been used.

(6) The method cannot be used to close perforations complicated by supraduodenal abscess.

#### REFERENCES

- <sup>1</sup>Deaver, J. M., and Pfeiffer, D. B. *Am. Surg.*, 73, 441, April, 1921.



- <sup>1</sup> Guthrie, Donald, and Shaler, Robert F J A M A , 107, No 13, 1018-1023, September, 1936
- <sup>2</sup> Kerr, Dr Harry In discussion of reference<sup>2</sup>
- <sup>4</sup> Moynihan Addresses on Surgical Subjects Saunders, 1928, 280
- <sup>5</sup> Beiman, J K, and Baxter, N E Arch Surg , 33, No 1, 1-18, July, 1936

DISCUSSION OF THE PAPERS OF DOCTORS MCGEEHEE AND GATCH

DR WILLARD BARTLETT, JR (St Louis, Mo) —I wish to express my appreciation of the honor of being granted the privilege of the floor and for Doctor McGehee's invitation to discuss his paper

We have not had in recent years such a case as Doctor McGehee describes in which chronic duodenal obstruction resulted from a developmental anomaly Perhaps you will find interesting what we have learned from the study of a patient in whom duodenal obstruction of a very high grade resulted from a marginal ulcer subsequent to gastro-enterostomy performed 13 years previously Obstruction was apparently complete as no bile had appeared in the stool for a number of days before treatment was instituted

The first objective in the preparation of such a patient for operation should be decompression of the obstructed bowel The ideal procedure would be continuation of such treatment until edema and spasm have disappeared, these are consequences of the inflammation and infection almost invariably associated with obstruction at any level of the gastro-intestinal tract The more nearly this ideal can be attained, the more safely and easily can manipulation and suture of the obstructed loops be carried out Decompression is readily brought about by the employment of continuous suction applied to an indwelling nasal catheter Since 1930, we have been using a simplified form of the apparatus described by Ward We prefer it to the Wangenstein apparatus for the latter is merely a siphonage and depends, in practice, upon the accumulation of measurable quantities of fluid in the stomach

We have reported the plan of measuring the rate of loss of body fluids aspirated from the stomach in ileus and the rate of disappearance from the stomach of ingested fluid as recovery occurs, referring to the former as a negative, and to the latter as a positive, "pyloric balance" The patient under discussion had a negative balance on eight consecutive preoperative days of 42, 26, 17, 27, 24, 15, 19, and 25 liters per 24 hours, respectively The immediate decrease in the value of the negative balance, from 42 liters to 17 liters on the third day of suction, reflected the subsiding of the edema and spasm and the conversion of the complete into an incomplete obstruction and bile reappeared in the stool The fact that the balance remained persistently negative after this occurred indicated the presence of a mechanical factor in the obstruction and this prediction was borne out at operation by the finding of both scar tissue and torsion as etiologic agents The large quantity of fluid, even if considered as only water, to be replaced daily is obvious, these amounts must be added to the daily minimum of 1,000 cc lost as insensible perspiration and the additional 1,000 cc to which we desire the urine should be diluted

DR J M T FINNEY (Baltimore, Md) —I have been much interested in both of these papers in Doctor McGehee's for the reason that it brings very vividly to my mind some experiences I had away back 30 or 40 years ago when I met with my first case of two of dilated duodenum I had not the remotest idea as to what it was, or what the cause of it was, but it did

not seem to me the same cause existed in every case. Some were definitely due to gastrosesenteric ileus. You could in such cases demonstrate a definite constriction of the bowel by the vessels, but there were other cases where I could not demonstrate any such obstruction.

The first group were amenable to operation, the operation suggested by Doctor McGehee. I first tried gastro-enterostomy. That helped some but it did not relieve them entirely. The type of case in which I could not demonstrate a definite obstruction was that curious type of thin, enteroptotic individual, long barreled and highly neurotic. It seemed to me an anatomic condition, or possibly functional—whatever that means—a disturbance in the innervation of the bowel wall, because as Doctor McGehee said, one of the things usually found present was an enormously dilated pylorus. The wall of the duodenum was very thin, so one could see through it. That type I gave up as inoperable, closed the abdomen, and turned the patient over to the medical men. My good friend Dr. Thomas R. Brown became interested and he was able to do more for them than I could. I did not know what the condition was and could not help much with surgery. I had some interesting correspondence at that time with Dr. W. J. Mayo and with the late Dr. A. J. Ochsner. They had both seen the condition. That was 30 or 40 years ago, and at that time neither of them had much to offer.

Doctor Gatch's paper interested me very much. In my experience these lesions are usually on the anterior wall and if we get them early enough and perform a pyloroplasty, we can excise the ulcer through the incision in the anterior wall of the stomach or duodenum. I have had very satisfactory results with these cases. If for any reason we cannot accomplish this, we must employ some substitute procedure, closing them as best we can. If we are not quite satisfied with the closure, we sometimes take a plug of omentum and suture it carefully over the opening, and then usually put down a small drain to the outside of the plug. One can usually do one or the other of these two things. Doctor Gatch's suggestion, I think, fills the bill beautifully. It seems so obvious that I do not know why some one did not think of it before. It should give a very satisfactory result.

DR. E. P. QUAIN (Bismarck, N. D.)—Since you were kind enough to offer me the privilege of the floor, I should like to refer to Doctor Gatch's paper. Some years ago I had the opportunity to become familiar with a method used by certain Scandinavian surgeons in operating for acutely perforated duodenal ulcers. It consists in merely closing the perforation with a suture or two and fastening a tag of omental fat over it and then performing a gastrostomy. This is done by putting a rubber tube into the stomach on the greater curvature about 10 or 15 cm. from the pylorus. The tube is pulled out through a stab wound to the left of the linea alba. This tube will empty the stomach and duodenum and keep them empty and at complete rest while the duodenal wound is healing. I have found this method more easily and quickly done than any of the more radical procedures described, and the postoperative results, both immediate and late, have been very satisfactory.

The subject of chronic duodenal obstruction has interested me for a long time. As some of you may remember, I translated the book Professor Duval wrote on this subject several years ago (Mosby & Co.). There is no question that chronic duodenal obstruction is an entity. In fact, it is several entities. To gain a true conception of this rather common, but complicated, ailment it is necessary to study the whole subject of visceroptosis.

Many obstructed duodena are relieved from operations directed to the cure of right coloptosis, others must have some form of short-circuiting made between the duodenum and the jejunum. But before we get far with these problems we must obtain the cooperation of a well qualified radiologist who has learned to look for other abnormalities in the duodenum than simply that of chronic ulcer. It is necessary also to have an internist, and nurses, properly interested in the subject, because so many of the examinations as well as treatments for these conditions are distinctly medical and not surgical in character. Many patients are relieved and carry on satisfactorily after being taught how to manage their visceroptosis by means of certain postures, binders, pads, *etc*. It is my conviction that our profession has not hitherto paid enough attention to this class of patients. My feeling of satisfaction on seeing some of these lank, lean, visceroptotic and neurasthenic cripples regain their weight and recover their physical and mental health has been one of the finest rewards I have received from the practice of surgery.

DR W O BULLOCK (Lexington, Ky) —I am convinced that there is such a thing as atonic dilatation of the duodenum, for I have had such a case. In this instance the duodenum and pylorus were dilated sufficiently to admit an ordinary sized glass tumbler—there was no obstruction. The wall was thin as Doctor Finney described. I performed a duodenojejunosomy but it did not function. It was easier for the duodenal contents to flow back into the stomach. I then closed the pylorus and performed a gastro-enterostomy which saved the patient's life. (She died six years later of tuberculosis.) I was impressed with the similarity of this condition of the duodenum to that of congenital dilatation of the colon, and believe that the answer to this question lies in the nerve plexus around the celiac axis which is distributed to this portion of the bowel.

DR GEORGE A HENDON (Louisville, Ky) —It stands us all in good stead to have as many expedients as possible, for we often meet with conditions that demand a special type of operation. One which I have had recourse to and which I have found a valuable procedure, particularly in those cases where the edges of the ulcer are cartilaginous and crumbly, and that will not hold the sutures, consists in loosening the upper part of the duodenum as far as the entrance of the common duct and pushing it up into the stomach. This brings four layers of mucous membrane and serous peritoneal surface over the ulcer. When that is accomplished, we perform a gastro-enterostomy to drain the stomach.

DR JOHN L McGEHEE (closing) —I wish to express my appreciation of the liberal discussion, and especially wish to express my appreciation to Doctor Finney for his observations regarding the subject. The idea in bringing this procedure before the Association was to bring out the fact that there is a type of obstruction of the duodenum, mechanical in nature, of congenital origin, and it is in this type that duodenojejunosomy rather than colopexy is indicated. There is another type in which the duodenojejunosomy does not remedy the situation and the results are disheartening. If the presentation of this case report has brought before you the idea that this condition exists as a clinical entity, and that it can be separated from the other type that is present in the female described by the poet as "limpid sweetness long drawn out," it has been well worth while.

# THE SURGICAL ASPECTS OF ACUTE CHOLECYSTITIS

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It is with a good deal of hesitation that I venture again to refer to a subject which has been so widely discussed in recent surgical literature. For many years the consensus of surgical opinion favored the conservative treatment of acute cholecystitis, meaning by this term the delay of operative therapy until the acute manifestations of the disease had subsided. An occasional surgeon thought of the advisability of early operation even though he may not consistently have practiced it, and I can recall assisting Halsted, about 1910, in performing a cholecystectomy in the acute stage of acute cholecystitis at a time when cholecystostomy was almost universally the operation practiced. Walton, an English surgeon, in 1923, advocated early or immediate operation in acute cholecystitis, drawing an analogy between the disease and acute appendicitis. But in this country, at least, the propriety of the conservative treatment of acute cholecystitis was not seriously questioned until about 1930. Since that time a number of authors—R. H. Miller,<sup>1</sup> H. F. Graham,<sup>2</sup> Mentzer,<sup>3</sup> Zinninger,<sup>4</sup> Stone and Owings,<sup>5</sup> Judd and Phillips,<sup>6</sup> and others, including myself<sup>7-10</sup>—either have questioned the wisdom of conservative treatment or have opposed it in favor of early operation. The subject is being actively debated in surgical literature, and I was interested to find that in the publications in American literature during the year 1936 writers on the subject are about equally divided, the one group advocating early operation, the other late operation. Some conservatives have become more conservative, for two authors state that if at the time of an emergency operation under a mistaken diagnosis, a simple acute cholecystitis without imminent perforation is encountered, the omentum should be wrapped around the gallbladder, the abdomen closed without drainage and the gallbladder removed at a second operation ten days to three weeks later.

When one studies the literature one is left with the impression that the clarification of certain matters often referred to might aid in determining the comparative value of early and late surgical treatment. I include some of these in the following questions:

(1) Has not the relationship between the clinical symptoms of acute cholecystitis and the pathologic course of the inflammatory process in the gallbladder an important bearing upon the question of early or late operation?

(2) Does the acutely inflamed gallbladder so rarely undergo gangrene and perforation as to disregard these complications as important factors in the treatment of the disease?

(3) Do the complications of gangrene and perforation of the gallbladder contribute so little to the mortality in disease of the gallbladder and bile

ducts that they may be disregarded in a plan of treatment of the disease?

(4) Is the danger to the patient of operating in the acute stage of the disease before gangrene and perforation have occurred greater than the danger of gangrene and perforation, the result of a conservative or waiting policy?

I have made an effort to find an answer to these questions. The material studied includes 150 cases of acute and chronic cholecystitis observed at the Cincinnati General Hospital, 800 cases from the records of the old New York Hospital and 614 cases observed since the opening of the new New York Hospital—a total of 1,565 cases. It includes, in addition, over 35,000 cases of disease of the gallbladder and bile ducts gathered from the more recent literature and some 1,500 cases specifically of acute cholecystitis. It will, of course, be impossible in the time allotted to this paper to report in detail the results of the study of this mass of material. I shall have to state only the conclusions at which I have arrived with respect to the questions I have propounded.

(1) A study of the relationship between the clinical symptoms of acute cholecystitis and the pathologic course of the inflammatory process in the gallbladder shows that there is no direct parallelism between them—in other words, that the clinical symptoms exhibited by the patient do not give any certain indications of the course of the pathologic process in the gallbladder—whether this be toward restitution or toward gangrene and perforation. A careful examination of the clinical symptoms, laboratory findings and pathologic records of 242 cases of acute cholecystitis, which I have personally observed, enables me to make some general statements which seem to hold true. There appears to be a relationship between a high leukocyte count and empyema, gangrene and perforation of the gallbladder and a relationship between the duration of the attack and the severity of the inflammatory process in the gallbladder. It appears that a distinction may be drawn between the cases of acute and subacute cholecystitis on the one hand and the cases of gangrene and gangrene and perforation on the other, and that this distinction lies in the higher temperatures, higher leukocyte counts and higher percentage of palpable gallbladders in the latter groups of cases. But when confronted with individual cases, these observations of a general nature are not very helpful. It remains a fact that in the presence of symptoms, urgent, subsiding or minimal, the pathologic process in the gallbladder not uncommonly proceeds to gangrene and perforation of the gallbladder, and it is often impossible to predicate from the clinical manifestations, the outcome of the disease. This has been the experience of others and is recorded in the literature.

Has not this relationship, or rather, this lack of relationship, a bearing upon the question of early or late operation in acute cholecystitis? In acute appendicitis the impossibility of accurately determining from the symptoms the course of the pathologic process in the appendix is one of the most important reasons for the present attitude toward early operation in this

disease. Since cholecystitis presents similar difficulties in the interpretation of its clinical and pathologic manifestations it would seem that the same reason for early operation is applicable to, and should be as valid in this disease. Those, however, who favor a waiting policy in acute cholecystitis point out that the two diseases are quite unlike in some respects—that in acute cholecystitis gangrene and perforation of the gallbladder are infrequent as compared with similar complications in acute appendicitis, and that when gangrene and perforation of the gallbladder occur, perforation into the free peritoneal cavity is far more rare than in acute appendicitis. They point out further that early operation of itself is more dangerous in acute cholecystitis than in acute appendicitis. These matters I shall go on to discuss.

(2) Does the acutely inflamed gallbladder so rarely undergo gangrene and perforation as to disregard these complications as important in the treatment of the disease? In 150 cases of cholecystitis observed at the Cincinnati General Hospital, 89 had acute cholecystitis, and of these, 18 had, at operation, gangrene and perforation of the gallbladder. This number of cases of gangrene and perforation represents 12 per cent for the general series and 20 per cent of the cases of acute cholecystitis. In 800 cases in the records of the old New York Hospital between 1922 and 1932 I found at least 106 cases of acute cholecystitis, of which 16 certainly, and seven additional probably, were cases of perforation of the gallbladder. This number of cases of perforation represents 3 per cent for the general series and 21 per cent of the cases of acute cholecystitis. In 614 cases of cholecystitis admitted to the new New York Hospital, 153 had acute cholecystitis and of these 40 had gangrene of the gallbladder, of which 16 showed definite perforation of the gallbladder. This number of cases of gangrene and perforation represents 6.5 per cent for the general series and 26 per cent of the cases of acute cholecystitis. In the experience of Judd and Phillips the incidence of gangrene and perforation in acute cholecystitis was 13.4 per cent, in that of Ziminger's series, 20.5 per cent, in that of Morris Smith,<sup>8</sup> 22.4 per cent. These and similar statistical data in the literature indicate that gangrene and perforation of the gallbladder occur in approximately 20 per cent of the cases of acute cholecystitis; the pathologic course of which is not interrupted by prompt and appropriate measures.

The statement so commonly made that perforation of the gallbladder occurs only in 2 to 3 per cent in a general series of cases tends to confuse rather than to clarify the situation. It is well known that in a general series, the cases of chronic cholecystitis outnumber the cases of acute cholecystitis, and we are, therefore, simply deceiving ourselves if we base our calculations upon a mixed group of cases, the preponderant number of which are largely outside the problem. When a case of acute appendicitis enters our surgical wards, few of us, I imagine, consider the incidence of gangrene and perforation of the appendix in a general series of cases of appendicitis; rather, we regard acute appendicitis as a condition by itself and weigh the chances of perforation without regard to the chronic form.

of the disease. Viewed in the same way—as I think it should be—gangrene and perforation of the gallbladder in acute cholecystitis occur far too commonly to be disregarded as important factors in the treatment of the disease. Let us compare its incidence with that of appendicitis at the New York Hospital. In the first 1,000 consecutive cases of appendicitis operated upon at the New York Hospital since 1932, there were 593 cases of acute appendicitis and 407 cases of chronic appendicitis. In the 593 cases of acute appendicitis, the appendix at operation showed all gradations of acute inflammation but had not perforated in 489 cases, and had perforated with the development of abscess or peritonitis in 104 cases. The incidence of gangrene and perforation in acute appendicitis in this series is, therefore, 17.5 per cent. The incidence of gangrene and perforation in acute cholecystitis observed during the same period is 15.7 per cent, a figure which is reduced to 10.5 per cent if we confine ourselves only to actual perforation with the development of extracholecystic abscess. These figures do not support the contention that perforation of the gallbladder in acute cholecystitis is rare compared to perforation of the appendix in acute appendicitis, although our experience supports the general experience that perforation of the gallbladder into the free peritoneal cavity is uncommon.

(3) Do the complications of gangrene and perforation of the gallbladder contribute so little to the mortality of disease of the gallbladder and bile ducts that they may be disregarded in a plan of treatment of this disease? In the Cincinnati series, the mortality following perforation of the gallbladder was 18.7 per cent, in the old New York Hospital series, it was 34.7 per cent, in the new New York Hospital series it was 12.5 per cent. In the experience of 14 authors with over 500 cases of perforation, the mortality varied between 15 and 65 per cent and averaged 46 per cent. Elason and McLaughlin,<sup>9</sup> in a study of 555 cases of perforation, found a mortality which varied between 11 and 58 per cent but averaged 47.6 per cent. In a study of 35,000 cases of cholecystitis made to determine the causes of its mortality, *this mortality, i. e.*, the mortality following perforation of the gallbladder, represents 10 per cent of the total mortality following the surgical treatment of noncancerous disease of the gallbladder and bile ducts. This mortality from perforation of the gallbladder in acute cholecystitis is sufficiently high of itself and goes contrary to the idea that it can be disregarded in a plan of treatment of the disease. But I wish to point out that it is not the only mortality which can be charged to gangrene and perforation of the gallbladder. In the study of over 35,000 cases of cholecystitis just referred to, I found that complications following operation, such as peritonitis, hemorrhage, shock, ileus, *etc.*, are responsible for approximately 35 per cent of the total mortality in operations upon the gallbladder and bile ducts, and it is perfectly clear that a part of this mortality is due to operative difficulties and postoperative complications the result of having to deal with the late manifestations of untreated acute cholecystitis such as longstanding extracholecystic abscess, liver abscess, fistulae between



gallbladder and neighboring viscera, adhesions and inflammatory stricture of the common duct

(4) Is it true, as is commonly stated, that the danger to the patient of operating in the acute stage of the disease is greater than the danger of gangrene and perforation of the gallbladder, the result of a conservative or waiting policy? There is still a fairly widespread opinion that there definitely is great danger to the patient in operating in the acute stage of the disease, a danger greater than that to which he is subjected due to gangrene and perforation of the gallbladder, extrahepatic abscess, peritonitis and other complications the result of conservative treatment. The causes of this presumed or real danger have been stated by some to be the failure of the patient to adjust himself to the acute infection, and the technical difficulties of the operation itself. It is rather difficult from the literature to get at the truth of the matter. The mortality in acute cholecystitis based upon the experience of eight authors in 1,275 cases varies between 4.7 and 22.5 per cent and averages 8.7 per cent, but it is clear that this mortality fails to show what it might have been if a deliberately early attack upon the disease had been made. The mortality in a general series based upon over 35,000 cases varies between 2.6 and 10.4 per cent and averages 6.6 per cent, but this mortality is an inclusive mortality and cannot properly be compared with the mortality in acute cholecystitis. I am able, however, to present a series of 153 consecutive cases of acute cholecystitis in which our policy has been consistently to operate early with the purpose of avoiding the dangers of gangrene and perforation, a policy, the reverse of the conservative policy. The adoption of this policy does not mean that we have operated upon every case as an emergency, for we have deferred operation in those cases in which pre-operative treatment seemed necessary\*. Nor does it mean that we have succeeded in eliminating gangrene and perforation, for as I have indicated, the gallbladder showed areas of gangrene in 40 of the 153 cases, and in 16 of these it was perforated on admission. But it does mean that the 153 cases were deliberately subjected to operation in the acute stage of the disease and with the hope of avoiding the serious complications referred to. In 138 cases, cholecystectomy was done, in 14, cholecystostomy with drainage and in one, abdominal drainage for generalized peritonitis. In the entire series there were five deaths, a mortality rate of 3.2 per cent.

Analyzed from the viewpoint of the extent of the disease, there were 137 cases of acute cholecystitis without demonstrable perforation of the gallbladder, with three postoperative deaths, a mortality rate of 2.1 per cent. In 16 cases with demonstrable perforation of the gallbladder and with extrahepatic abscess (15) and generalized peritonitis (one), there were two

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\* Sixty-five per cent of the cases were subjected to operation the day of admission, 35 per cent were observed 48 hours or more before operation was performed. Delay in operation was more often due to difficulties in differentiating between acute cholecystitis and other acute abdominal conditions with which it may be confused, than to the time consumed in getting patients in favorable condition for operation.



deaths, a mortality rate of 12.5 per cent. This mortality rate is actually lower than the average mortality rate in the collected series of 35,000 cases of gallbladder disease quoted above and, with one exception (Judd and Parker<sup>11</sup> 1,036 cases, mortality 2.6 per cent), is lower than the mortality rate in general series of cases reported from individual clinics. Our experience, while admittedly not large, raises the question whether, after all, the danger of operating in the acute stage of acute cholecystitis is well founded. I think it has been overemphasized and is distinctly a less grave danger than that of gangrene and perforation to which the patient is subjected as a result of conservative treatment.

**SUMMARY**—I have found as the result of a study of a large number of cases of acute and chronic cholecystitis that the clinical symptoms, physical signs and laboratory data in acute cholecystitis often fail accurately to indicate the course of the pathologic process in the gallbladder. In the acutely progressive type of the disease, the clinical manifestations fairly closely parallel the pathologic process in the gallbladder, but in other cases, even in the presence of subsiding or minimal symptoms, the pathologic process in the gallbladder may proceed to gangrene and perforation of the organ. Until we have more accurate methods of diagnosis, it would seem proper to take this fact into consideration in our treatment of the disease, just as we do in acute appendicitis, and especially so, if gangrene and perforation occur with any considerable frequency and contribute considerably to its mortality. It appears with respect to gangrene and perforation that these complications occur approximately in 20 per cent of all cases of acute cholecystitis, the pathologic course of which is not interrupted by surgical measures. It appears further that these complications are responsible, under a deferred plan of treatment, for a mortality in acute cholecystitis which varies greatly in the experience of different observers but which rarely in the literature is below 20 per cent and often is as high as 40 per cent, and that this mortality represents approximately 10 per cent of the total mortality in the surgical treatment of non-cancerous disease of the gallbladder and bile ducts. This incidence of gangrene and perforation and this mortality are sufficiently high not to be disregarded in a plan of treatment of this disease, unless it be true that they are less a menace to the life of the individual with acute cholecystitis than operation performed early in the disease and with the purpose of avoiding them. That they are not less dangerous but distinctly more dangerous than operation in the acute stage of the disease is suggested by an experience derived from a study of 153 cases of acute cholecystitis in which operation in the acute stage has deliberately been planned and, so far as possible, consistently carried out with the purpose of attempting to lower the mortality from gangrene and perforation of the gallbladder. In this series, the total mortality is 3.2 per cent, but when analyzed from the viewpoint of the extent of the disease, the mortality in 137 cases in which cholecystectomy was performed before perforation had occurred is 2.1 per cent, the mortality in 16 cases subjected to operation after perforation had occurred is 12.5 per cent.

This mortality is so favorable in comparison with the published statistics of mortality rates following the surgical treatment of cholecystitis that I feel justified in continuing a method of treatment which is opposed to the conservative method

# REFERENCES

- <sup>1</sup> Miller, R H Acute Cholecystitis ANNALS OF SURGERY, 92, 644, 1930
- <sup>2</sup> Graham, H F The Value of Early Operation for Acute Cholecystitis ANNALS OF SURGERY, 93, 1152, 1931
- <sup>3</sup> Mentzer, S H The Acute Gallbladder Manifesting Few Signs or Symptoms Surg, Gynec and Obstet, 55, 709, 1932
- <sup>4</sup> Zimninger, M Treatment of Acute Cholecystitis ANNALS OF SURGERY, 96, 406, 1931
- <sup>5</sup> Stone and Owings The Acute Gallbladder as a Surgical Emergency ANNALS OF SURGERY, 98, 760, 1933
- <sup>6</sup> Judd and Phillips Acute Cholecystic Disease ANNALS OF SURGERY, 98, 771, 1933
- <sup>7</sup> Heuer, G J Errors in Diagnosis and Treatment of the More Common Acute Abdominal Conditions West Virginia Med J, 26, 11, 1930
- <sup>8</sup> Smith, M K Treatment of Acute Cholecystitis ANNALS OF SURGERY 98, 766, 1933
- <sup>9</sup> Elason and McLaughlin Perforation of the Gallbladder ANNALS OF SURGERY, 99, 914, 1934
- <sup>10</sup> Heuer, G J Factors Leading to Death in Operations upon the Gallbladder and Bile Ducts ANNALS OF SURGERY, 99, 881, 1934
- <sup>11</sup> Judd and Parker Mortality Following Operations on the Biliary Tract, Pancreas and Liver ANNALS OF SURGERY, 84, 419, 1926

# STRICTURES OF THE COMMON AND HEPATIC DUCTS

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THE subject of strictures of the main bile ducts has been previously discussed in papers from this Clinic, in several papers from other clinics and by individuals particularly interested in the subject. The fact that a great many cholecystectomies are being performed daily, that injuries to the ducts are occurring constantly, that they result in most serious situations and finally that in a considerable experience with this type of lesion we have, in the different cases, employed a variety of procedures to meet varying situations makes it desirable, we believe, to report some of our experiences with these complications, and to describe and illustrate the nine different procedures which we have successively employed in dealing with these strictures.

We have now operated upon 35 patients with stricture of the common or hepatic duct and it seems to me but simple justice to the surgeons of this Clinic to state that in no case did the stricture follow an operation performed in this Clinic.

The causes of stricture of the common and hepatic ducts are quite limited in number. We have seen one case of complete obliteration of the bile duct undoubtedly due to an inflammatory process which completely destroyed the mucosa within the common and hepatic ducts, converting that structure into a fibrous cord without a lumen. Other surgeons have reported such an experience but this fortunately appears to be of quite rare occurrence. Ulceration of the common or hepatic duct or perforation of these structures due to ulceration about a stone occasionally occurs and the formation of a stricture following such an occurrence, as shown in Fig. 1, has occurred in our experience. For practical purposes nearly all of the strictures of the common and hepatic ducts are man-made strictures and the result of clamping either the hepatic or common duct in an endeavor to catch and control the cystic or right hepatic artery when torn off in the course of performing a cholecystectomy. This mistake, as shown in Fig. 2, is by far the most common cause of stricture, particularly of the hepatic duct and occasionally of the common duct. If the history of the previous operation in these cases be obtained from the hospital where the original operation was performed, in a majority of the cases of stricture, particularly of the hepatic duct, there will be a description in the operative findings of troublesome cystic artery hemorrhage which was finally controlled by clamps. There will also not infrequently be a history of a prolonged discharge of bile following these operative procedures. In a few other cases, as shown in Fig. 3, an entire section of the common and hepatic ducts will have been removed due to traction upon the cystic duct, angulation or peaking of the common and hepatic ducts so that the right-angled clamp, as shown in Fig. 3, grasps

not the cystic duct but the common and hepatic ducts, severing or ligation of which produces either the removal of a segment of common or hepatic duct or, as shown in Fig 4, incomplete removal of the anterior wall of the duct at the point where the common and hepatic ducts join. An occasional stricture will result from trauma as illustrated in Case 7, an occasional stricture

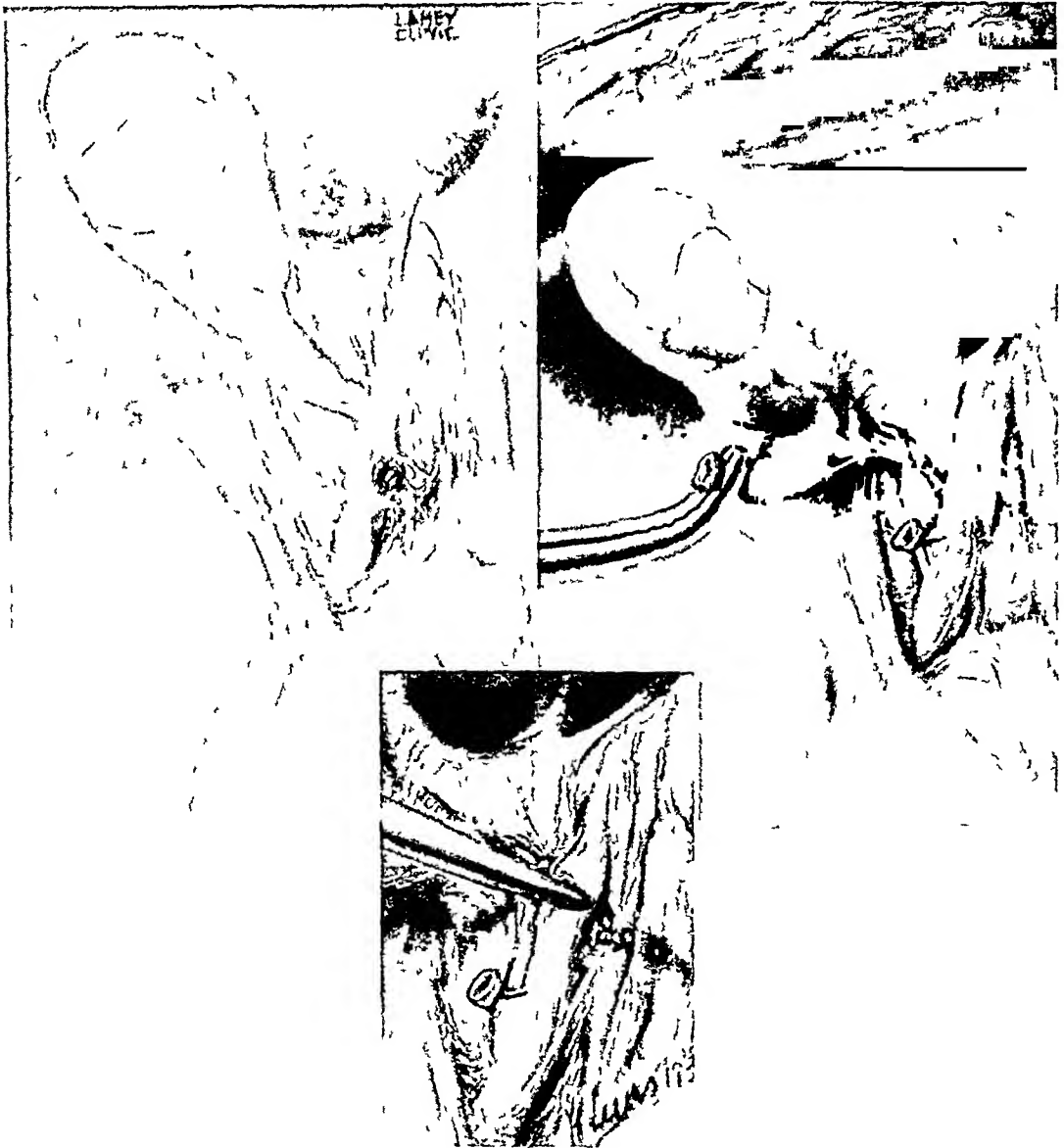


FIG 1—The method by which a stone ulcerating through the common duct can produce a stricture

Insert shows how a clamp which catches the bleeding end of the cystic or right hepatic artery can also catch the hepatic duct and cause stricture

FIG 2—Showing how when the cystic duct is clamped and cut before the cystic artery is clamped and cut traction is upon the artery and can tear that structure, causing annoying hemorrhage

low in the common duct following an operative procedure, as in Case 9, will be difficult to explain but is likewise probably due to clamping. There will be, occasionally, patients in whom secondary inflammatory bands may interfere with drainage of the common duct as demonstrated in Case 8.

One should be suspicious of stricture of the common duct in any patient

in whom jaundice appears within a reasonably short time following a previous cholecystectomy unless that cholecystectomy has been performed by the observer and he is quite certain that no injury can possibly have resulted to the common or hepatic duct. When a patient has, in the history of his previous operation, a story of cystic or right hepatic artery hemorrhage controlled by clamping or a history of prolonged drainage of bile following cholecystectomy in connection with technical difficulties during the operation, one should be suspicious that this jaundice is the result of a secondary stricture. When in addition this jaundice appears from three, four to five months after cholecystectomy and is painless in character, one should be additionally suspicious that this jaundice is the result of the development of a stricture of the common or hepatic duct.

That strictures of the common or hepatic duct can exist for a number of months or years without the occurrence of marked jaundice seems from our experience quite certain. This is probably due to the fact that the lumen of the strictured duct, while narrowed, is still of sufficient caliber to permit the passage of enough bile as long as that bile is quite normal and of a thin consistency. When, however, secondary infection in the bile passages occurs with thickening of the bile, the appearance of flocculi of mucus together with perhaps an inflammatory reaction within the duct mucosa, this is very probably the factor in these cases which produces late jaundice and obstructive symptoms. When jaundice such as is associated with obstruction of the common or hepatic duct due to stricture occurs, it is painless in character, gradual in onset, late after the previous operation in terms of weeks or months as has already been described, and there is very little that can be done in the way of diagnostic measures to confirm the possible suspicions of a stricture of the common duct. The diagnosis in these lesions must be made largely from the past history and from inference.

A great deal has been written on the treatment of strictures of the common and hepatic ducts. We have published articles on the production of complete external biliary fistulae and the later transplantation of these fistulae into the duodenum, stomach or jejunum. As I have personally stated in the literature and in discussions on this subject, this has for the most part proved an unsatisfactory operative procedure and based upon our experience now with 14 such cases, is an operation which should be reserved as a last resort measure for those patients who have such high strictures at or above the point where the hepatic duct divides into the right and left branches that direct anastomoses between the duodenum or jejunum and the open end of this strictured duct cannot be effected. Based upon our personal experience with this transplantation operation, and because we have written about it, it is my duty, I believe, to state that this operation is far inferior to the direct anastomosis as proposed by Dr. W. J. Mayo, in which the opened end of the hepatic duct is accurately anastomosed to the mucosa and muscularis of the duodenum or jejunum. Unfortunately direct duct anastomosis will not be possible in a small percentage of cases and in such cases the operation

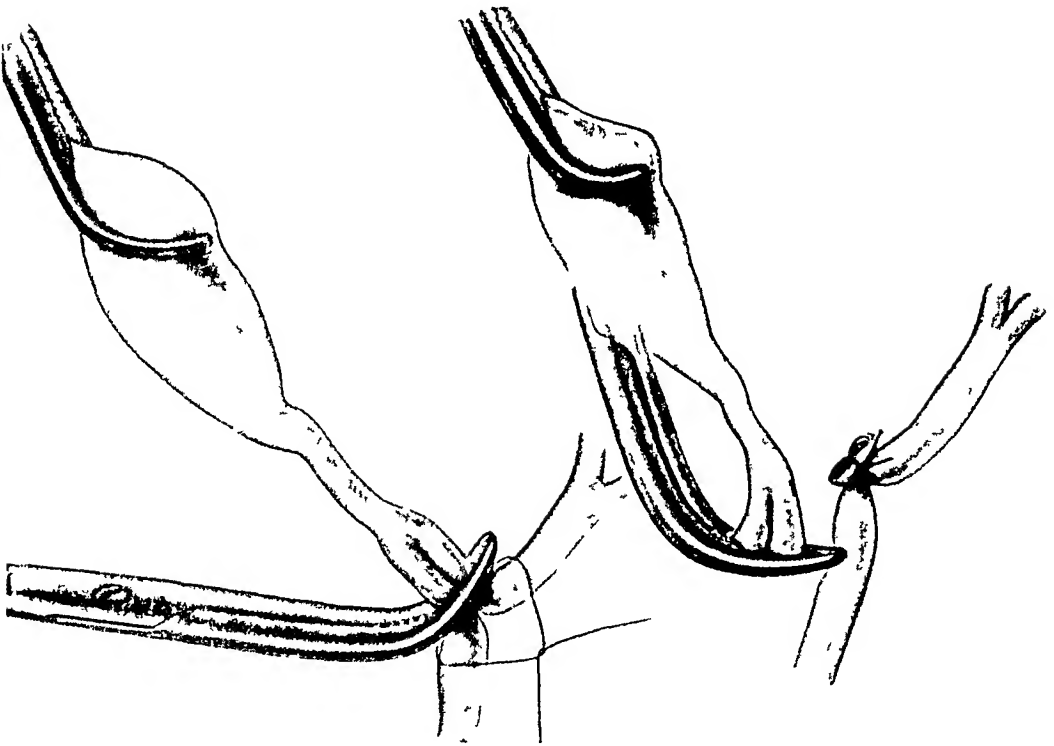


FIG 3—Showing semidiagrammatically how an entire section of the common and cystic duct may be removed by applying the clamp too low after pulling up on the cystic duct as occurred in Case 2



FIG 4—Showing semidiagrammatically how stricture of the duct can result from applying the right angle clamp in cholecystectomy so far down on the cystic duct that it grasps part of the wall of the common and hepatic duct and ligation at this point produces a stricture. Probably the cause of stricture in Case 6

which we have described in the literature and which was first employed by Dr Hugh Williams of Boston becomes justifiable in application, since it is then the only procedure possible

The variety of experiences which we have had with strictures of the common and hepatic ducts can, we believe, best be demonstrated by presenting a few features of nine successfully treated cases, each by a different method, by illustrations of the operative procedures employed in each case and follow up reports as to the end-results

### CASE REPORTS

Case 1—Mrs N, age 27 Origin of the stricture, cholecystectomy performed September 9, 1930 Patient made a good recovery but drained bile for eight weeks Her

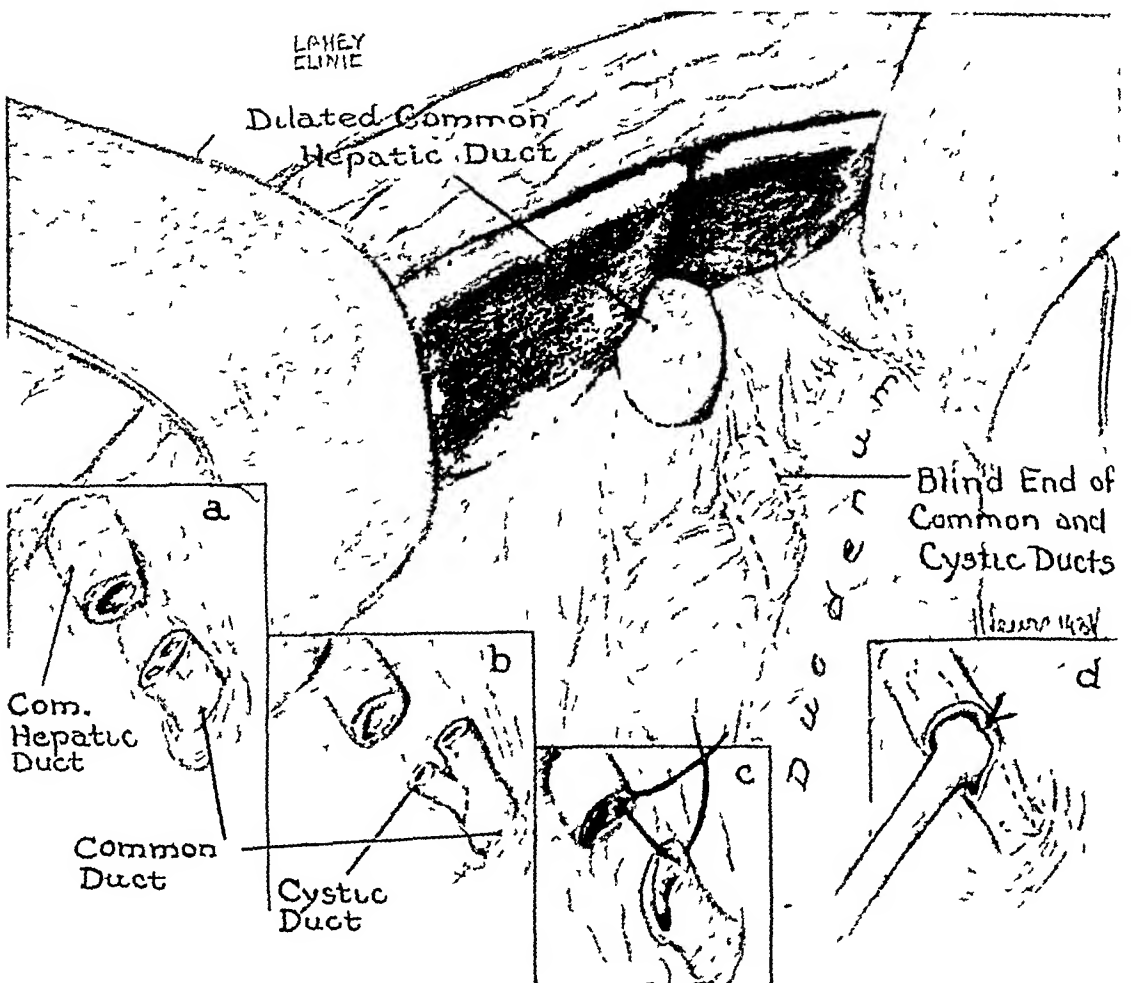


FIG 5 —End to end anastomosis of common duct for complete division of duct following cholecystectomy

stools were clay colored during this time Drainage ceased in the last week in November, 1930, and stools became colored at this time During the first week in December, 1930, the patient became jaundiced and stools clay colored Jaundice, high colored urine and itching persisted until she entered the Clinic on February 12, 1931 (five months after original operation)

After a period of preparation she was operated upon February 17, 1931 Conditions as presented in Fig 5 were found In the main portion of the illustration may be

seen the blind and dilated end of the hepatic duct, and the blind ends of the common and cystic ducts. In Insert a may be seen the end of the common hepatic duct, trimmed off, the end of the common duct, trimmed off, together with the entrance of the cystic duct embedded against the contracted common duct. In Insert b may be seen the stump of



FIG 6—Complete division of common and hepatic ducts caused by low placing of clamp at time of cholecystectomy

the cystic duct dissected free, and in Insert c, the cystic duct incised to serve as a cuff of tissue, also the posterior guide suture bringing together the back wall of the dilated hepatic duct and the enlarged common duct. In Insert d may be seen the T tube inserted, one end in the lumen of the hepatic duct and the other in the lumen of the common duct. The ends of the common and hepatic ducts were brought together about this tube, covered with a layer of omentum and the tube allowed to remain in the common duct for several weeks. Following this the patient had a miscarriage, a subphrenic and a pelvic abscess. The subphrenic and pelvic abscesses were drained. She made an excellent recovery and has had an excellent result. A report in May, 1935, shows no jaundice, patient in excellent condition in every way. A later report, December 3, 1936, states that the patient has never been as well in her life, that she is in her fifth month of pregnancy, uneventful so far, no pain, and no jaundice five years after operation.

This case represents a successful end-to-end anastomosis of the severed duct, now of five years' standing with a good result. One of the features making this case successful and remarked upon in the description of the operation is the ease with which the ends of the severed ducts were brought together. When there is any tension due to the defect from loss of the duct itself, stricture will occur and undoubtedly one of the successful features of this case is that there was sufficient slack in the duct to bring the ends together without tension.

**Case 2**—Miss W, age 25. This patient was operated upon ten months previously after an attack of abdominal pain and vomiting. A diagnosis of acute appendicitis was made and she was operated upon elsewhere. At this time, her appendix was removed.



and an empyematous gallbladder, which was greatly dilated was also removed. On the twelfth postoperative day, she began draining bile, which continued for six weeks and which has persisted, intermittently, since. The sinus opens and closes and when closed the patient feels nauseated and becomes jaundiced. She was admitted to the Clinic ten months after the original operation. She was jaundiced, had lost 12 pounds, her skin was itching, the stools were clay colored and the urine highly colored.

The surgeon referring the case frankly described what he had done at the operation of removal of the gallbladder, as shown in main portion of Fig. 6. A right-angled clamp had been placed sufficiently low so that both the common and hepatic ducts were caught

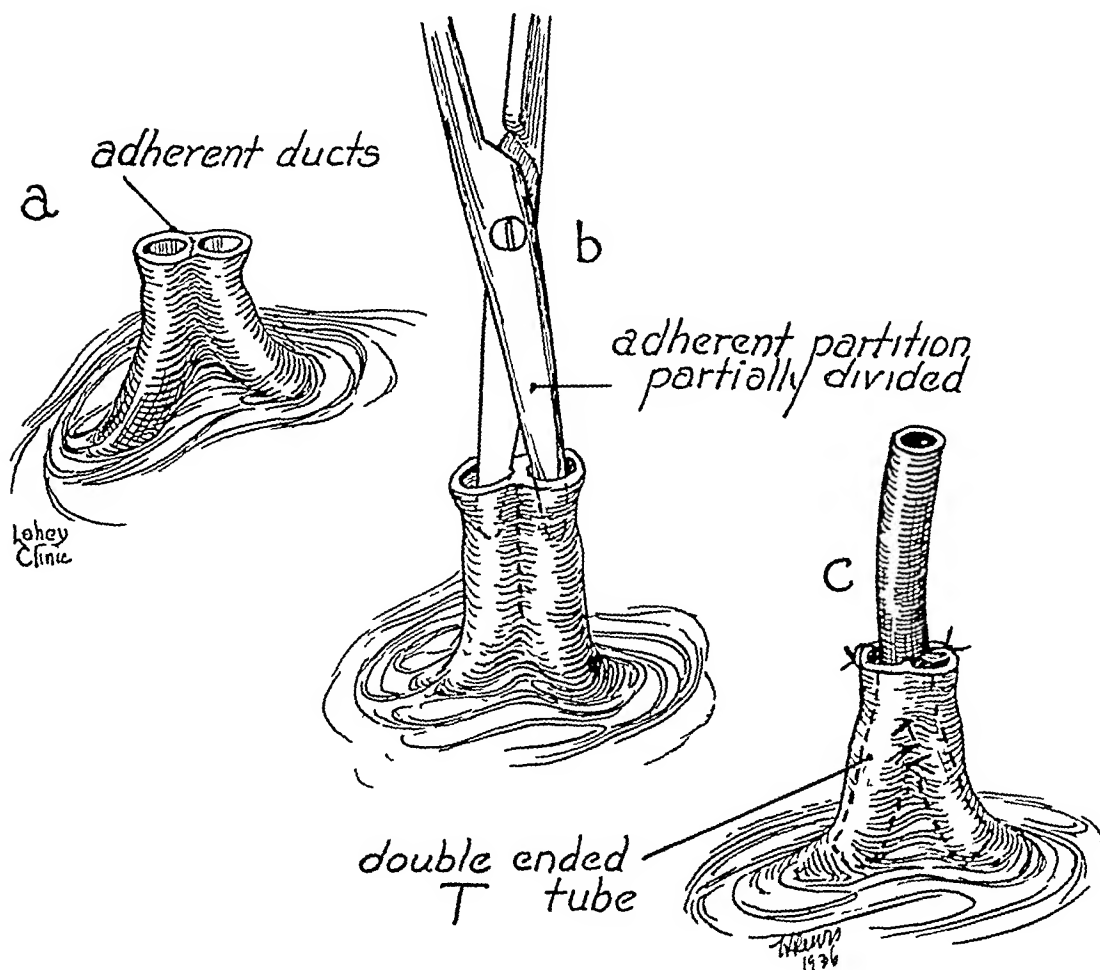


FIG. 7.—Management of common duct stricture seen in FIG. 6

in a clamp, which were tied and cut across, and when the gallbladder was removed, the gallbladder stump contained not only the cystic duct but a section of the hepatic and common ducts, the hepatic and common ducts being tied together as shown in Insert a.

At operation the end of the hepatic duct was found adherent to the end of the common duct (Fig. 6, Insert a), in the position that a Mikulicz anastomosis would be, both ends of the ducts being blind and closed. The ends of the common and cystic ducts were opened (Fig. 7a). The posterior walls of the two ducts were cut through as in a Mikulicz operation (Fig. 7b), a T tube inserted into the hepatic duct and into the common duct and the ducts sutured about the tube (Fig. 7c). The tube within the ducts was worn from the date of operation, September 11 1935, until January 4 1936, at which time the T tube was removed. There has been complete relief. The sinus tract promptly closed following removal of the tube, there has been no jaundice, no pain and no obstruction. Patient gained 25 pounds in weight and was in excellent condition November 25 1936, 14 months after operation.

The approximation of the ducts by the Mikulicz principle was possible in this case by the fact that the inclusion of both ducts in the ligature at the first operation established fusion of the ducts on their posterior wall and overcame tension.

**Case 3**—Mr. A., age 53, was brought to the Clinic by the surgeon who had operated upon him, with the history that on September 5, 1935, while performing a cholecystectomy for acute cholecystitis, there occurred a serious hemorrhage from what appeared to be a branch of the hepatic artery, and in the attempt to control the bleeding point, the hepatic duct had been grasped with a clamp. For 11 weeks postoperatively, this patient drained bile. After the abdominal sinus closed, he developed jaundice for a few days. The wound then broke open and discharged for a few days but again closed shortly without the appearance of jaundice. He had no jaundice until February, 1936, when it returned and has persisted until the present time, June 14, 1936. He has lost 30 pounds in weight. His stools have been clay colored most of the time but occasionally there has been a little bile in them.

At entrance to the Clinic, he was deeply jaundiced. Bilirubin index 8.6. He was operated upon June 19, 1936, five days after entrance. A long, complete stricture of the hepatic duct was demonstrated running up to the bifurcation of the right and left branches of the hepatic duct (Fig. 8a). The distal end of the common duct was smaller than the dilated branches of the hepatic duct, due to the fact that it had not been functioning. The dilated blind stump of the hepatic duct at the point of division was so great that direct anastomosis could not be effected between the ends of the ducts. The hepatic duct stump was so short and imbedded in the liver that an anastomosis between the end of the duct and the duodenum was also impossible.

The dilated hepatic duct at the junction of division of the right and left branches of the hepatic was incised with the escape of a large amount of "white" bile. The undilated portion of the common duct distal to the stricture was opened (Fig. 8b). The scar tissue between the two was incised to make a trough into which a No. 18F catheter was laid (Fig. 8c and d). One end of this catheter passed down into the common duct but not through the ampulla of Vater into the duodenum. The ampulla of Vater was demonstrated to be patent. The upper end of the catheter rested in the dilated hepatic duct at the point where it divided into a right and left branch. The edges of the scar tissue of the stricture were accurately sutured over this No. 18F catheter and reinforced with the surrounding peritoneum. The suture was effected so accurately that there seemed no danger of leakage (Fig. 8e). A cigarette drain, however, was placed at the foramen of Winslow and the wound closed.

There was immediate drainage of bile into the duodenum, the bilirubin index three days after operation had dropped to 3.6. The jaundice immediately began to clear and on the twenty-fifth, six days after the operation, dropped to 3.4, and on the twenty-sixth, seven days after the operation, to three milligrams. On the twenty-eighth, to 2.6. On July 2, to 2.5, and on July 6, 17 days after operation, to 2.1. This patient made an uneventful recovery and never had any subsequent drainage of bile. The cigarette drain was removed on the eighth day. The wound closed firmly. He has gained 25 pounds in weight, and a letter from his physician, December 1, 1936, states that he had no difficulties whatever.

This case presented a difficult problem. The stricture was so high, running as it did up to the division of the hepatic into its right and left branches, and so deep in the bed of the liver that an anastomosis between the opened end of the hepatic duct and the duodenum or jejunum would have been very dangerous, if not impossible. The length of the stricture was so great

# STRICTURES OF COMMON AND HEPATIC DUCTS

that end-to-end anastomosis or any plastic operation upon the duct was out of the question Our experience with the production of external biliary fistulae and then transplantation has been so unsatisfactory that it did not

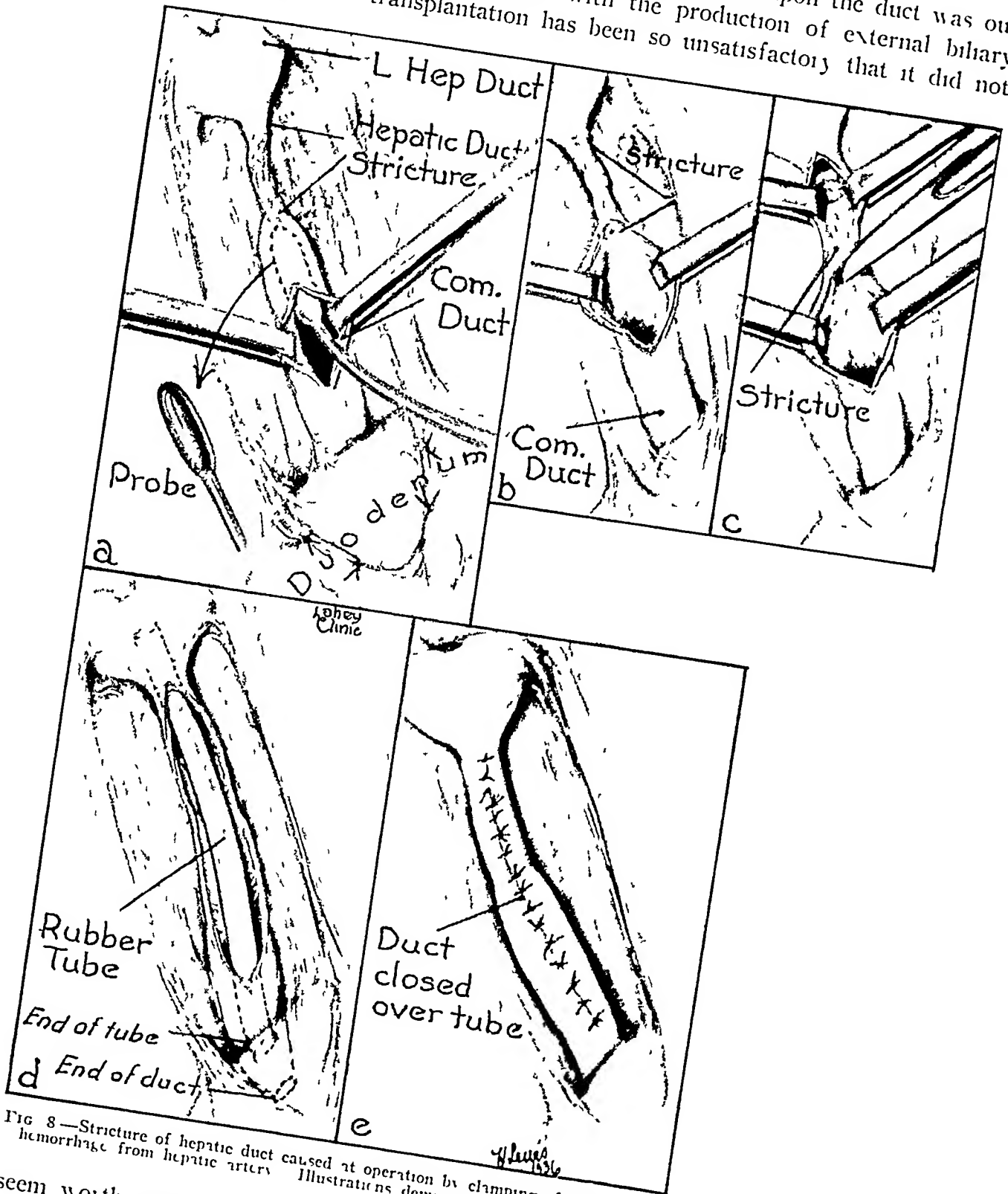


FIG 8—Stricture of hepatic duct caused at operation by clamping of the duct in an attempt to control hemorrhage from hepatic artery Illustrations demonstrate method of treatment of this stricture

seem worth considering It must be admitted that the introduction of a rubber tube into the common duct to replace the duct is in some measure a makeshift procedure, but in this patient there seemed nothing else to do and

so far the results have been most gratifying and satisfactory. It is of interest to note that we have removed a tube from a common duct which had functioned well for seven years and replaced it with another still functioning satisfactorily. It will be of interest to observe this case and should he have difficulty with this tube eventually, I feel sure that there will be no difficulty in replacing it. On the one hand, we had a patient deeply jaundiced with no method of reconstructing the duct with his own tissue, and on the other, the uncertainty associated with the introduction of a foreign body. So far, now six and one-half months after the introduction of the tube, it has proved a completely satisfactory substitute for the destroyed duct.

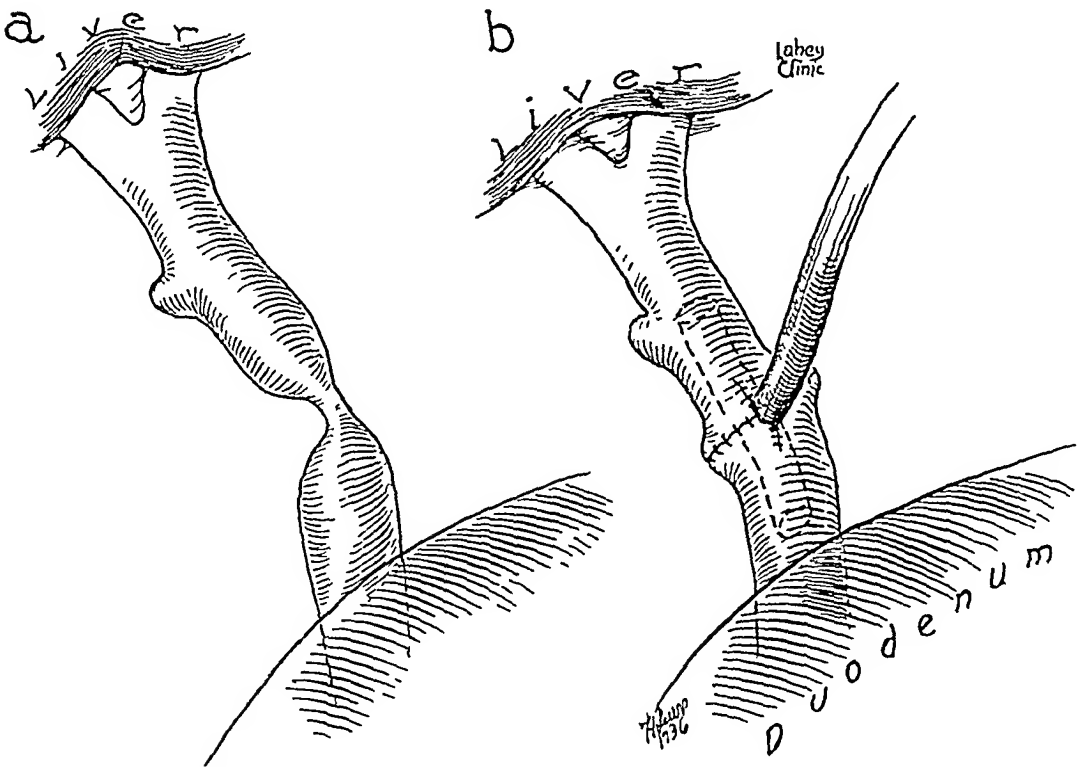


FIG 9—Stricture of common duct caused by operative trauma and method of management

**Case 4**—Father S, age 59, was operated upon in 1931 for abdominal pain, jaundice, nausea and vomiting. The operative report states that the patient was obese and the operation difficult. He had symptoms of bile duct obstruction immediately after the operation while still in the hospital, was repeatedly jaundiced, and since the operation, up to the time of his entrance to the Clinic, February 6, 1936, he has had almost weekly attacks of pain and jaundice. At the time of entrance he was jaundiced and was admitted with the diagnosis of probable common duct stricture with or without stones.

Operation was performed February 10, 1936. The dense adhesions from the previous operation were separated from the bed of the liver and the gastrohepatic ligaments isolated. The dilated common duct, at a point just below where the cystic duct enters the junction of the common and hepatic, was found, opened, and several gallstones were removed. The bile in this dilated common duct was thick and definitely infected. The right and left hepatic ducts were explored and all stones removed from them. It was then found impossible to pass a probe downward into the lower portion of the common duct. A search was made for a small fistulous opening but none could be identified.

The common duct was then found distal to this apparently blind end of the common duct, it was isolated and opened. It was dilated to about the size of a man's thumb. When this portion of the duct was opened, a fistulous connection between the two segments of the duct was found which measured approximately two millimeters in diameter. The stricture in this portion was very short, representing practically a diaphragm between the two ends of the common duct. The anterior portion of this diaphragm or stricture was incised, a large T tube was placed in the strictured portion with one arm going into the hepatic and one into the common duct (Fig 9). The common duct was reconstructed about this so that the reconstructed portion was of greater caliber than the rest of the duct. The lower end of the common duct was investigated to make sure that the ampulla of Vater was patent and dilators readily passed through it into the duodenum. A small cigarette drain was placed down to the foramen of Winslow and the wound closed.

This patient made a very satisfactory recovery, returned home with the T tube in place for four months. The jaundice promptly cleared up. The T tube was removed without difficulty at the end of four months. Bile drained freely into the intestinal tract and all external drainage ceased following removal of the T tube. The last report, December 2, 1936, ten months after the operation, is that this man is in excellent condition with no further jaundice.

The fact that this patient had a very narrow stricture amounting almost to a diaphragm, the fact that it could be reconstructed with no tension whatever on the duct, offers, we believe, excellent prospect of a good result in this case.

Case 5—Mrs K, age 42, had a cholecystectomy performed in March, 1934, about one year before admission to the Clinic. Following the removal of her gallbladder she drained bile for six weeks. She was in relatively good health after convalescence from her cholecystectomy until December, 1934, about nine months after operation. On January 1, 1935, she became jaundiced, her urine dark, and stools light colored, and she began to lose weight. The jaundice had steadily, progressively and painlessly increased. Her stools, however, contained a small amount of bile. The report of her first operation states that after the gallbladder was removed, it was found so dilated that there was no cystic duct, that the common and hepatic ducts ran directly from the gallbladder and both had been cut. At the time of operation, a T tube was introduced into both ends of cut ducts which were then brought together over the T tube. This patient was admitted to the Clinic March 11, 1935, one year after her cholecystectomy, with a diagnosis of stricture of the common or hepatic duct. She showed plus four jaundice, was dehydrated, and suffered from severe pruritus. She had lost 30 pounds in weight. Bilirubin index 11.6.

Operation, March 15, 1935. The gastrohepatic omentum was freed of the adhesions resulting from the previous operation with difficulty, and the dissection was carried down to the region of the common and hepatic ducts. The proximal stump of the hepatic duct was found dilated and about the size of an adult's thumb, projecting out from the bed of the liver for a distance of about two centimeters (Fig 10). The distal end of the common duct was not seen. An old, partly obliterated fistula seen along the usual course of the common duct was demonstrated and was not opened because of the dense scar tissue and because it would have been impossible to have reconstructed the duct. It was decided to anastomose the dilated end of the hepatic duct to the duodenum. An accurate anastomosis was effected between the stump of the hepatic duct and the duodenum (Fig 10), a double layer of interrupted sutures accurately approximating the mucous membrane of the duodenum to that of the duct.

The operative recovery was uneventful, there was no discharge of bile, the stools became promptly colored and have remained so since. The bilirubin index on the

eighteenth, three days after operation, had dropped to 89, on the twenty-first, six days after operation, to 41 and fell progressively to normal. An uneventful recovery ensued. A report, December 5, 1936, states that she is and has been perfectly well, and represents the typical and satisfactory case, in which it is possible to make a direct anastomosis between the cut end of the duct and the duodenum.

**Case 6**—Miss F, age 28, entered the Clinic March 19, 1936. She had had a cholecystectomy 18 months previously, in July, 1935. Her physician reports that at the time her cholecystectomy was performed the common and hepatic ducts were injured and repaired. Following this repair, the patient drained bile for three months, after which time the sinus closed. Following closing of the sinus, the patient was well for one month, when she became jaundiced, which has since become progressively deeper.

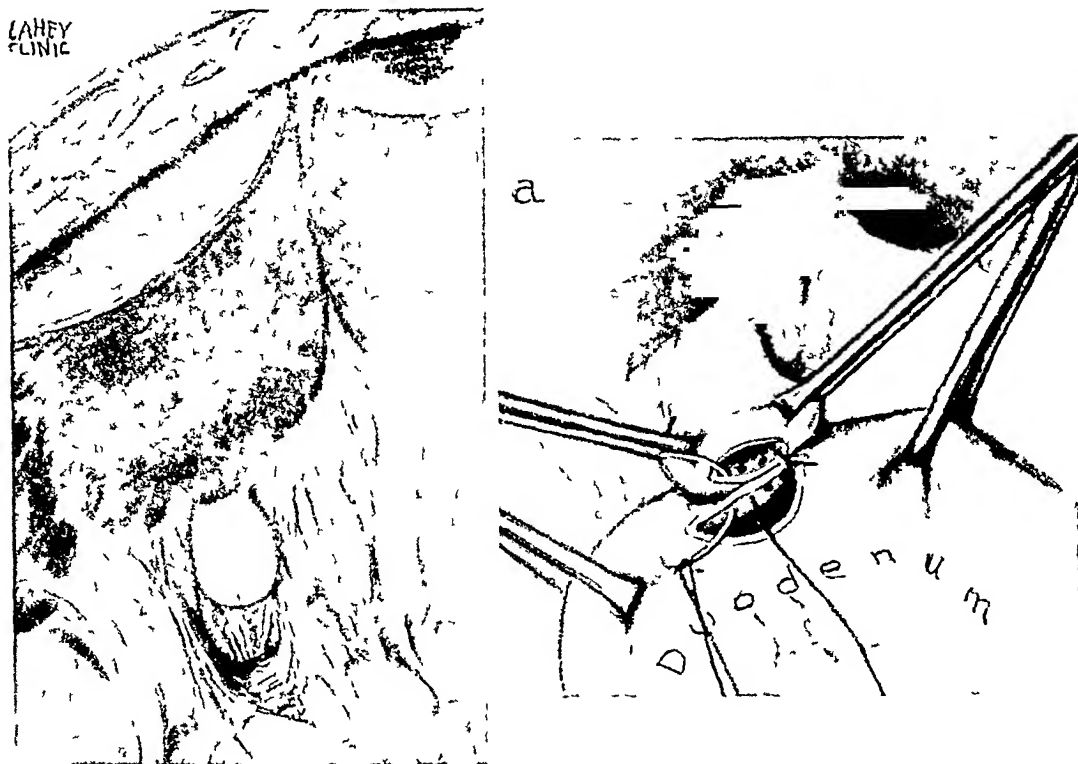


FIG 10—Anastomosis of stump of cystic duct to duodenum for complete division of common duct

She has lost 50 pounds in weight since her operation. On admission she was deeply jaundiced with an enlarged liver, and an incisional hernia. Bilirubin index 10.1. She was admitted with a diagnosis of stricture of the common duct.

**Operation, March 23, 1936.** The dense scar tissue resulting from the previous operation was dissected away from the liver, the gastrohepatic ligament demonstrated, and the duodenum found to be drawn tightly against the liver at the base of the gallbladder fossa. After dissecting the duodenum away, the dilated hepatic duct was found markedly distended with bile, and the common hepatic duct was dissected free and isolated. The common hepatic duct was opened and noted to contain clear hepatic bile (Fig 11). A definite stricture of very short length was found to exist between the hepatic and the common ducts, which was incised longitudinally. The lower limb of a size No 18F T tube was passed through it and into the duodenum. This tube was passed through the incised stricture by way of an incision in the hepatic duct above the level of the stricture. The upper limb of the T tube was cut short so that it would reach into the right hepatic duct. The strictured portion of the duct was reconstructed after the Heineke-Mikulicz

plan over the lower limb of the T tube in order to widen the lumen of the duct at the expense of its length. This allowed the duct to be well closed, to be of greater caliber than the duct itself and the suture line was under no tension whatever. A cigarette drain was placed down to the foramen of Winslow, it having been previously demonstrated that the sphincter of Oddi was patent, the wound was closed.

The bilirubin index on March 27, four days after operation, had dropped from 10.1, its height at entrance, to 4.9. Three days later, on the thirtieth, to 3.6, and from then on it gradually fell to normal. This patient has made an excellent recovery and at the last report, December 1, 1936, was in excellent condition.

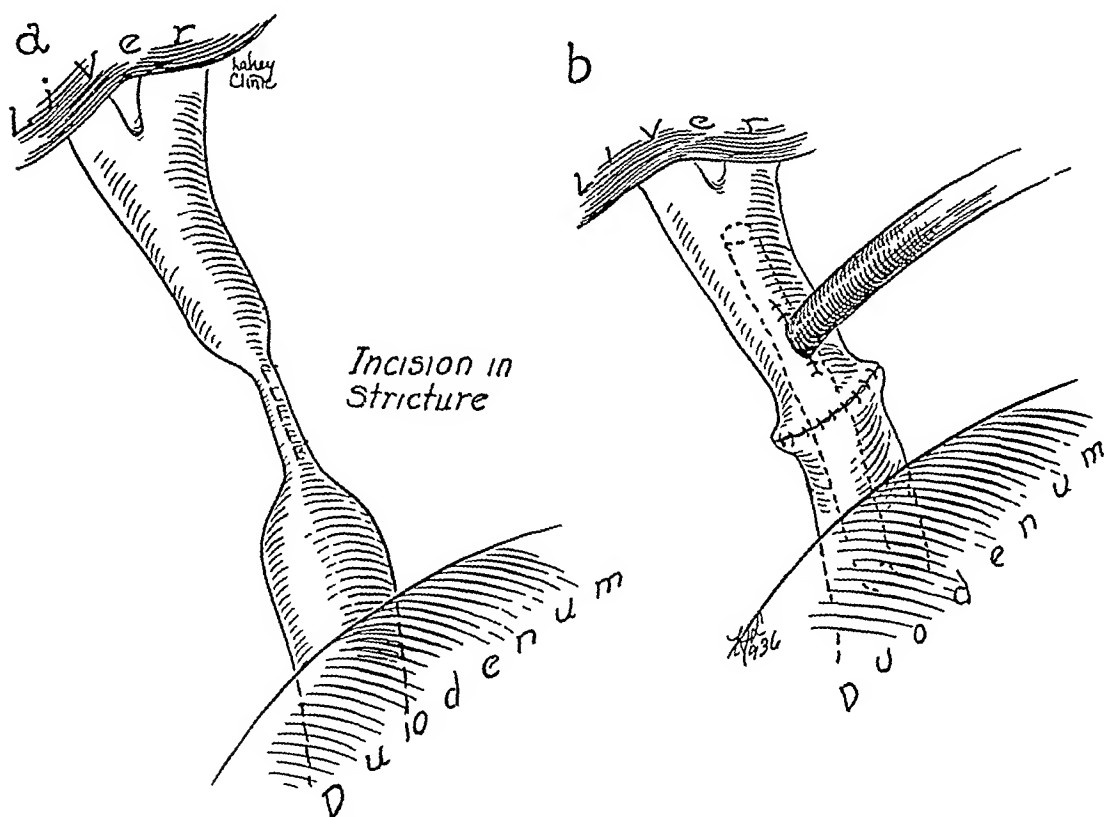


FIG. 11.—Longitudinal incision of common duct stricture and closure about "T" tube. Note position of upright limb of "T" tube in relation to line of closure of stricture.

This case represents a method of closing the duct over a T tube with the upright limb of the tube emerging through the unstricted portion of the duct and the duct completely sutured about the lower end of the T tube. This, when possible, is much superior to the suture of the duct about a tube which emerges through the center of the suture line as shown in Fig. 9, since the removal of the tube may very well break down the suture line and the defect left by its removal result in a stricture.

**Case 7**—Mrs. M., age 27, entered the Clinic September 20, 1930. She had been in an automobile accident July 26, 1930, remaining in a hospital for three weeks, where she was told that she had intra-abdominal injuries. She had a good deal of vomiting but soon after returning home noticed that her eyes were becoming yellow. She was admitted with a diagnosis of questionable catarrhal jaundice. Duodenal drainage was instituted September 24. On stimulation, 50 cc. of turbid yellow material were obtained which contained considerable mucus and pus and tall columnar epithelial cells. The gallbladder did not empty and no conclusion could be drawn. She was discharged from the hospital three weeks later and returned to the Clinic two months later, the jaundice having persisted and having become deeper. She suffered from severe pruritus, the stools were a

very light brown, and her urine very dark. In view of the fact that this jaundice had persisted for four months and had become more intense, it did not seem likely that her condition was due to catarrhal jaundice, on the other hand, she had no pain, or evidence of stones or malignancy.

Operation, February 14, 1931. On exploration her gallbladder was found slightly enlarged and distended, with thick walls. A cicatricial area was found just above the duodenum over the common duct, and a large soft area was noted in the liver substance filled with necrotic pale brown material (Fig 12). This was evacuated. It was apparently an old rupture of the liver in which healing had not completely taken place. The scar tissue in the neighborhood of the duodenum completely occluded the common duct. The gallbladder was opened and found to contain dark, green bile. The hepatic duct was opened and the right and left hepatic ducts were probed and found to be patent, but the duodenum could not be entered because of the scar tissue resulting from the previous trauma. A T tube was inserted in the right hepatic duct and a large drain was inserted into the gall bladder (Fig 13). These drains were inserted for the purpose of relieving the existing jaundice and the anticipated relief of stasis resulting after the contemplated anastomosis of the gallbladder to the stomach, duodenum or jejunum at a later date.

Her bilirubin index at entrance was 10.7. On February 26, 12 days after operation, it was 6.3, and on March 2, 18 days after operation, it was 5.4. Following this, with further drainage from the gallbladder and hepatic duct, the bilirubin index soon became normal. The catheter was withdrawn from her hepatic duct 12 days after operation and she continued to drain bile well from her gallbladder. The patient was sent home draining all of her bile from her gallbladder sinus, to return for secondary anastomosis of the gallbladder to the stomach or duodenum.

On April 27, two and one-half months after the original drainage operation, since all bile was being discharged through the gallbladder fistula, the patient was reoperated and the fundus of her gallbladder anastomosed to the stomach. She made an excellent recovery. A report, November 27, 1936, states that she is in good health, with no difficulties.

This patient represents a traumatic stricture of the common duct, drainage of the gallbladder and hepatic duct for relief of jaundice, and successful secondary anastomosis of the gallbladder to the stomach.

Case 8—Miss B, age 40, entered the Clinic May 19, 1936, because of nausea and abdominal pain. She had had a cholecystectomy in July, 1935. This is said to have been performed for nausea, vomiting, and upper abdominal pain. One stone was found in the gallbladder. She felt well for two or three weeks following operation, when she had another attack of pain and vomiting very similar to the first one, and these have recurred at frequent intervals since that date. Jaundice has not been noted since the operation. She was admitted with a diagnosis of possible common duct stones. Bilirubin index normal, there were no evidences of jaundice, and her stools were well colored. Duodenal drainage was attempted, but because of pylorospasm, could not be satisfactorily conducted. In the course of the attempted duodenal drainage the patient had attacks of pain characteristic of those of which she had previously complained, consisting of a severe twisting and grinding epigastric pain, radiating through into the back, but not referred to the shoulder. It was colicky but did not subside completely between each wave of pain. It required morphine to relieve it. Roentgenologic examination of the stomach showed a somewhat distorted, sensitive duodenum with evidence of adhesions in the second portion, producing sharp angulation. The note from the Gastro-Enterologic Department stated that since the patient has never been jaundiced either before or after operation a year ago, the character of the pain and the failure to find stones in the common duct at the time of her previous operation make it unlikely that she has a com-



Fig. 12—Stricture of common duct following into accident with intra abdominal injuries

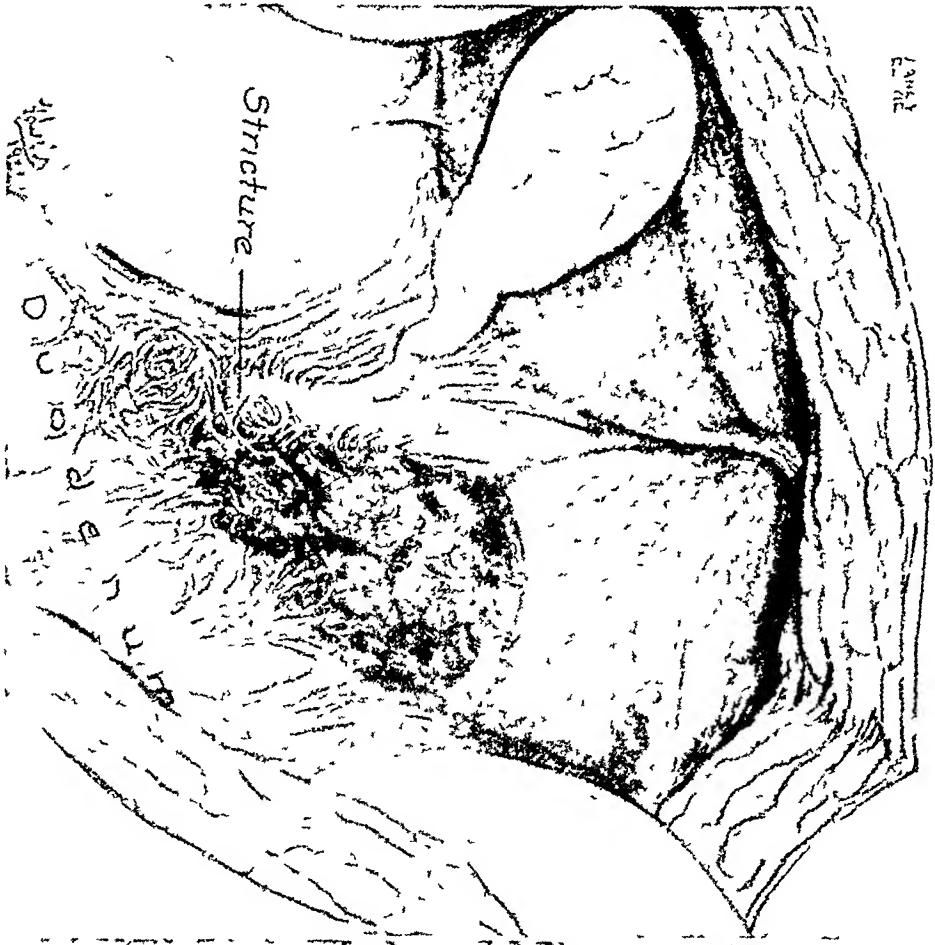
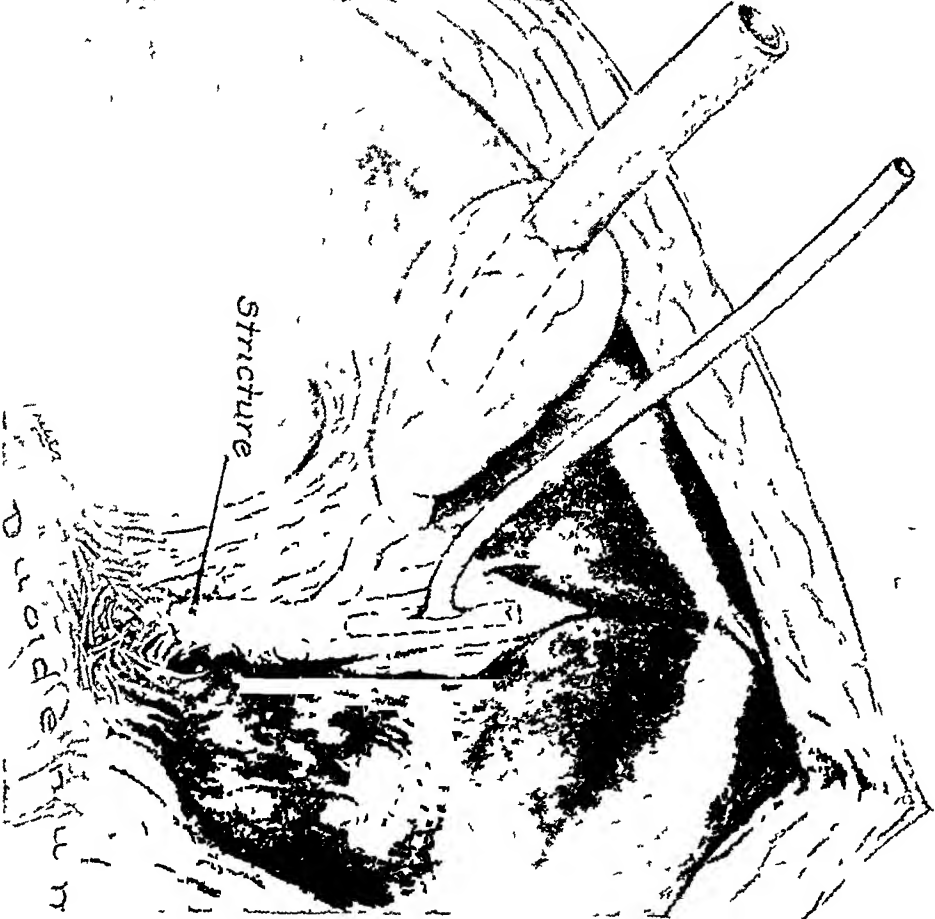


Fig. 13—Drainage of hepatic duct and gallbladder preliminary to cholecyst gastrostomy



mon duct stone The probable diagnoses are Duodenal adhesions, recurrent subacute pancreatitis

Operation, May 25, 1936 The duodenum was found drawn upward beneath the liver, adherent to that structure at the point where the gallbladder had been removed, covering the lower portion of the gastrohepatic ligament On freeing the duodenum and turning it down from its abnormally high position, a widely dilated common duct was seen This duct was covered anteriorly by the right hepatic artery which made an abnormally sharp curve to the right About one and one-half inches above the point where the common duct becomes retroduodenal, a firm adhesive band passed between the right hepatic artery, across the common duct in such a position as to produce a very marked constriction and marked dilatation of the common duct above this point This band so tightly constricted the duct that it gave the impression that a string had been tied about the duct at a point just below what appeared to be the ballooned-out portion of the duct above the obstructed region The distal end of the common duct at a point below the constriction was the size of a normal common duct (Fig 14a) On cutting this adhesive band with scissors, the duct at the point of obstruction at once returned to its normal size It was opened and explored (Fig 14b) No stones or further strictures were found A No 7 Bakes' dilator passed easily into the duodenum A T tube was placed in the common duct and a cigarette drawn to the foramen of Winslow An uneventful recovery followed and a report, July 24, 1936, showed no gastro-intestinal symptoms, or any trouble whatsoever A later letter, December 3, 1936, reports that this patient has had no return of the pain since operation, no indigestion or nausea and has gained 12 pounds in weight

This case represents cicatricial obstruction of the common duct by a band following a previous cholecystectomy, severing of which resulted in complete relief It is of interest to realize that such bands can exist and that, as shown in Fig 14, marked dilatation of the duct can result from these, and symptoms of incomplete obstruction can result

Case 9—Mrs K, age 55, had had a cholecystectomy in January, 1935 At that time her bile duct was opened but no stones were found She had previously had two severe attacks of pain accompanied by slight jaundice Three days after operation, she became deeply jaundiced, nauseated, and vomited The jaundice persisted for six or seven weeks causing intense pruritus In October, 1935, she entered the Mercy Hospital in Pittsburgh where at a second operation the common duct was reported to have been found as large as a segment of intestine and a stricture was found at about the point where the common duct passes behind the duodenum A T tube was inserted in the common duct for the relief of the jaundice which cleared up after about two months Following removal of the T tube a complete external biliary fistula persisted up to January, 1936, at which time the discharge of bile ceased and the stools showed a little color The fistula started draining again after three days and has persisted to the present time

She entered the Clinic March 20, 1936, with a Grade II icterus All bile was discharging from the biliary fistula and the stools were clay colored Bilirubin index 17 A diagnosis of stricture of the common duct was made

Operation, March 24, 1936 The external biliary sinus was carefully dissected down to its point of origin at the common duct midway between the point where the cystic duct enters the common duct and where the common duct becomes retroperitoneal This fistulous tract was well nourished, was not attached to the bed of the liver and could be separated and kept intact The common duct was then carefully separated from its numerous adhesions and found to be markedly dilated The stump of the cystic duct was found adherent to the portal vein behind the common duct, it was isolated and carefully freed This duct was about the size of one's little finger and about one inch in

# STRICTURES OF COMMON AND HEPATIC DUCTS

length The junction between the cystic duct and dilated common duct was carefully dissected and identified There was no evidence of stones in the common duct, but a definite fibrous stricture just above the duodenum was demonstrated (Fig 15) It was

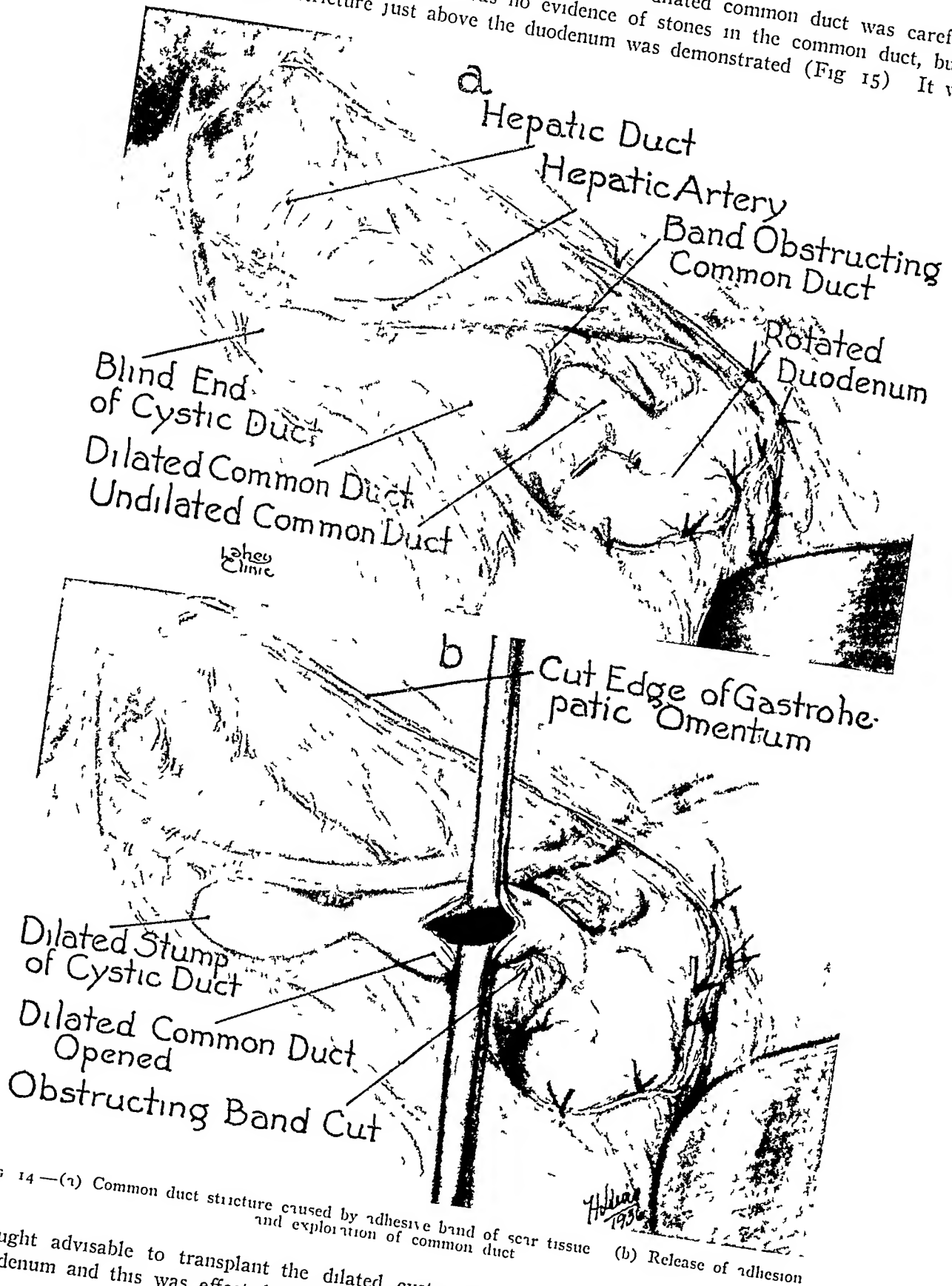


FIG 14—(a) Common duct stricture caused by adhesive band of scar tissue and exploration of common duct (b) Release of adhesion

thought advisable to transplant the dilated cystic duct into the first portion of the duodenum and this was effected without difficulty The end of the dilated cystic duct

was cut off, a small section of rubber catheter was tied into the opened end of the cystic duct so that it would not be strictured by the purse string which is placed in the duodenum when implanted (Fig 16a) It was implanted into the duodenum by two guide sutures and anastomosed to the duodenum by a circular purse string suture (Fig 16b)

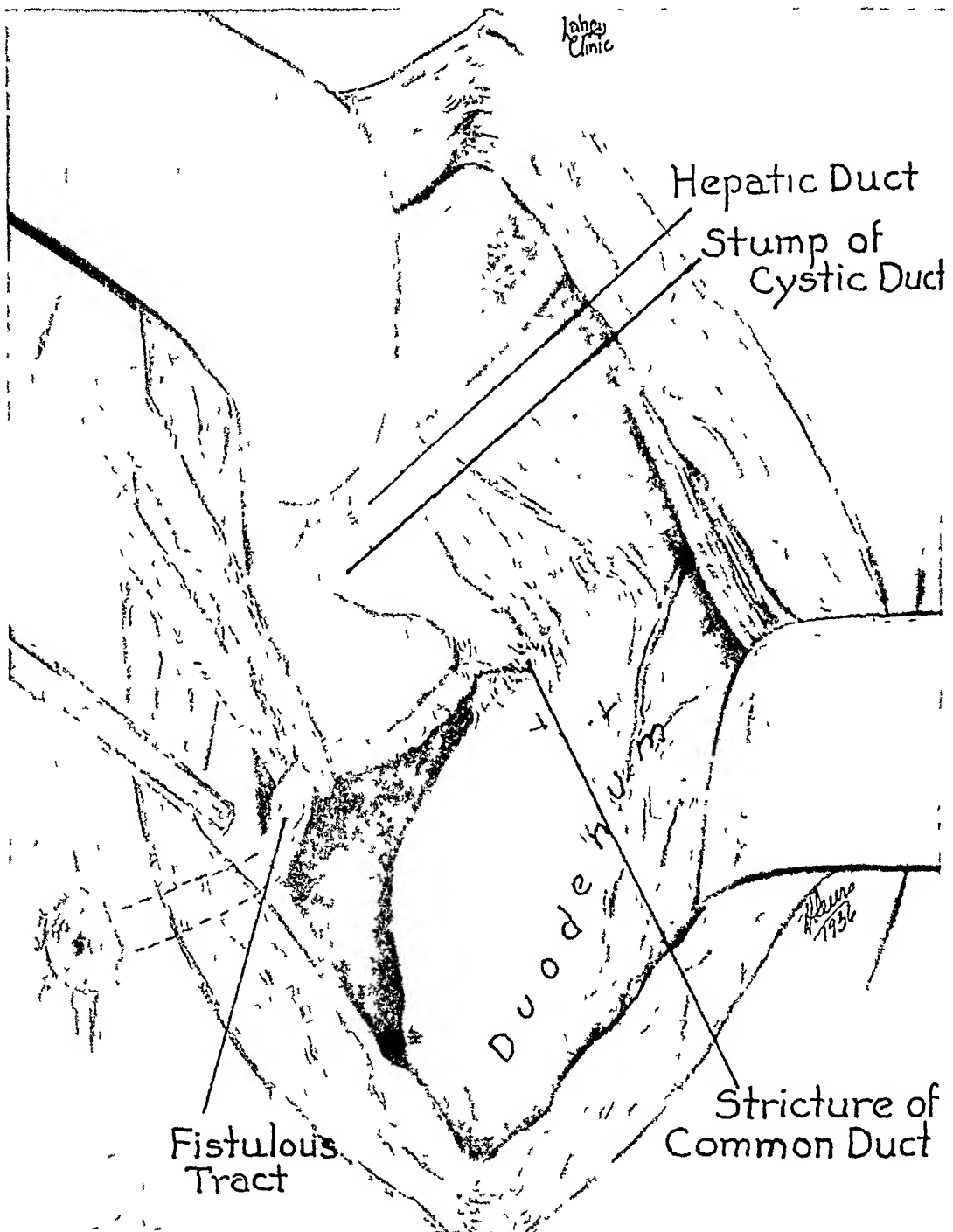


FIG 15—Stricture of common duct caused by adhesions just above the duodenum and fistulous tract of external biliary sinus

One of the problems of the operative procedure was the disposition of the biliary fistula. If this were left in the wound, it would discharge bile and infect the wound. It therefore seemed wise to implant the end of this fistula into the stomach in order to care for its

## STRICTURES OF COMMON AND HEPATIC DUCTS

Two openings were made in the stomach beyond the pylorus (Fig 17a) A hemostat was passed through the opening nearest the cardiac end of the stomach and out of the opening near the pyloric end of the stomach The fistulous tract was then pulled into the stomach, the incision near the pylorus closed about it and the incision in the stomach toward the cardiac end closed (Figs 16b and 17a and b) This resulted in a discharge of all the bile from the common and hepatic ducts through the cystic duct, implanted into the duodenum, and a discharge of any bile along the fistulous tract into the stomach where it would not infect the wound Following completion

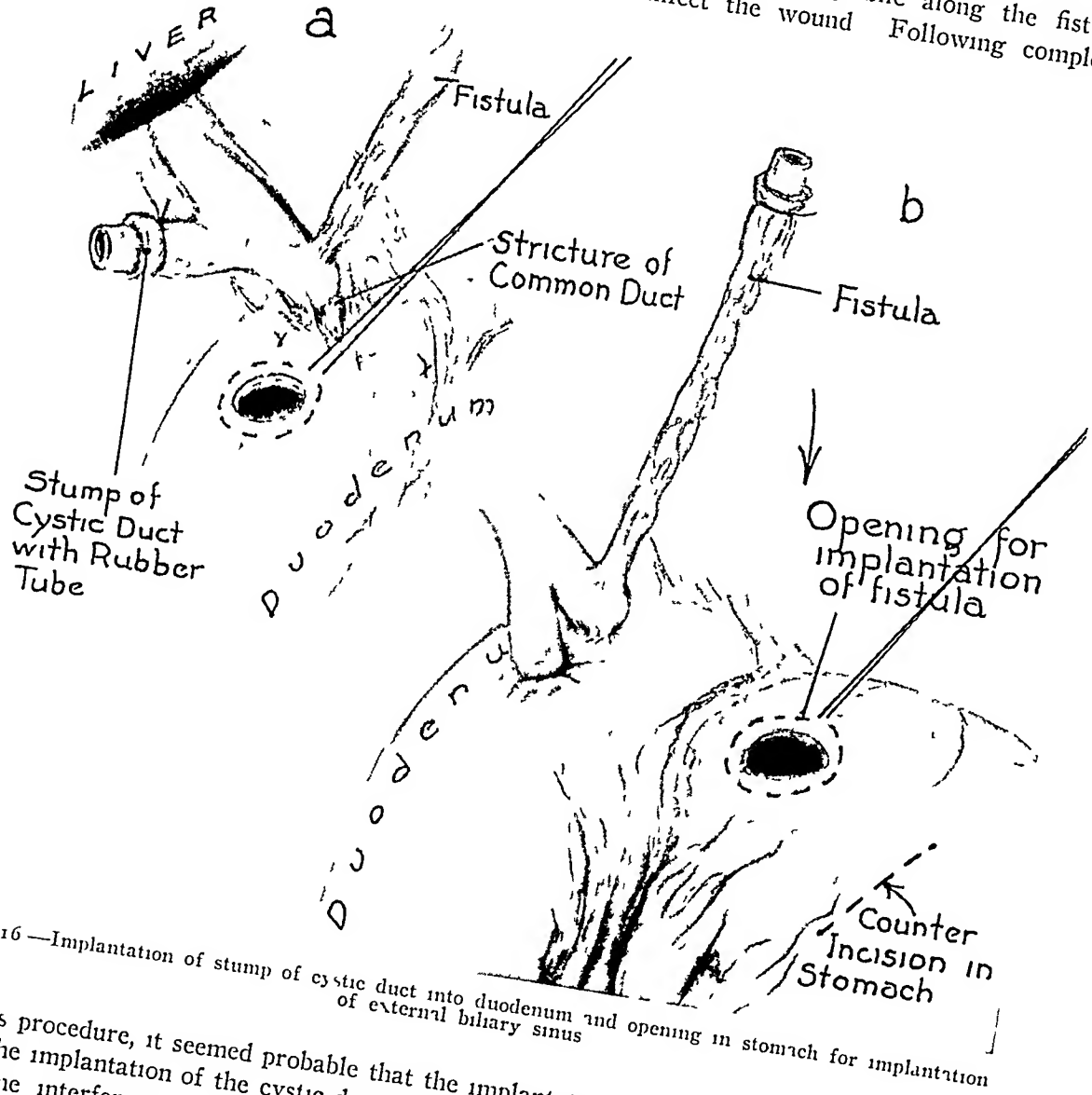


FIG 16—Implantation of stump of cystic duct into duodenum and opening in stomach for implantation of external biliary sinus

of this procedure, it seemed probable that the implantation of the fistula near the pylorus, plus the implantation of the cystic duct into the duodenum near the pylorus, might result in some interference with pyloric function Gastro-enterostomy was then performed without difficulty and the wound closed (Fig 17c) This patient made an excellent recovery and had no postoperative difficulties whatever Her bilirubin which rose for a time after operation soon became normal and she is now entirely free from symptoms A report, November 28, 1936, states that she is, and has been, perfectly well with no jaundice and no symptoms

This case represents the rather complicated problem of rerouting the bile from the obstructed common duct (probably seriously injured when opened at the original operation, and not the result of the procedure at the

second operation) into the duodenum and at the same time arranging for the disposal of the discharge of any bile from the tract of the external biliary fistula. This problem was very satisfactorily managed by implantation of the end of the dilated stump of the cystic duct into the duodenum and by implantation of the fistulous tract into the stomach. The gastro-enterostomy, while possibly unnecessary, had to be performed as a precaution against pyloric obstruction, since, had the pyloric obstruction eventuated postoperatively, the secondary performance of a gastro-enterostomy would have been

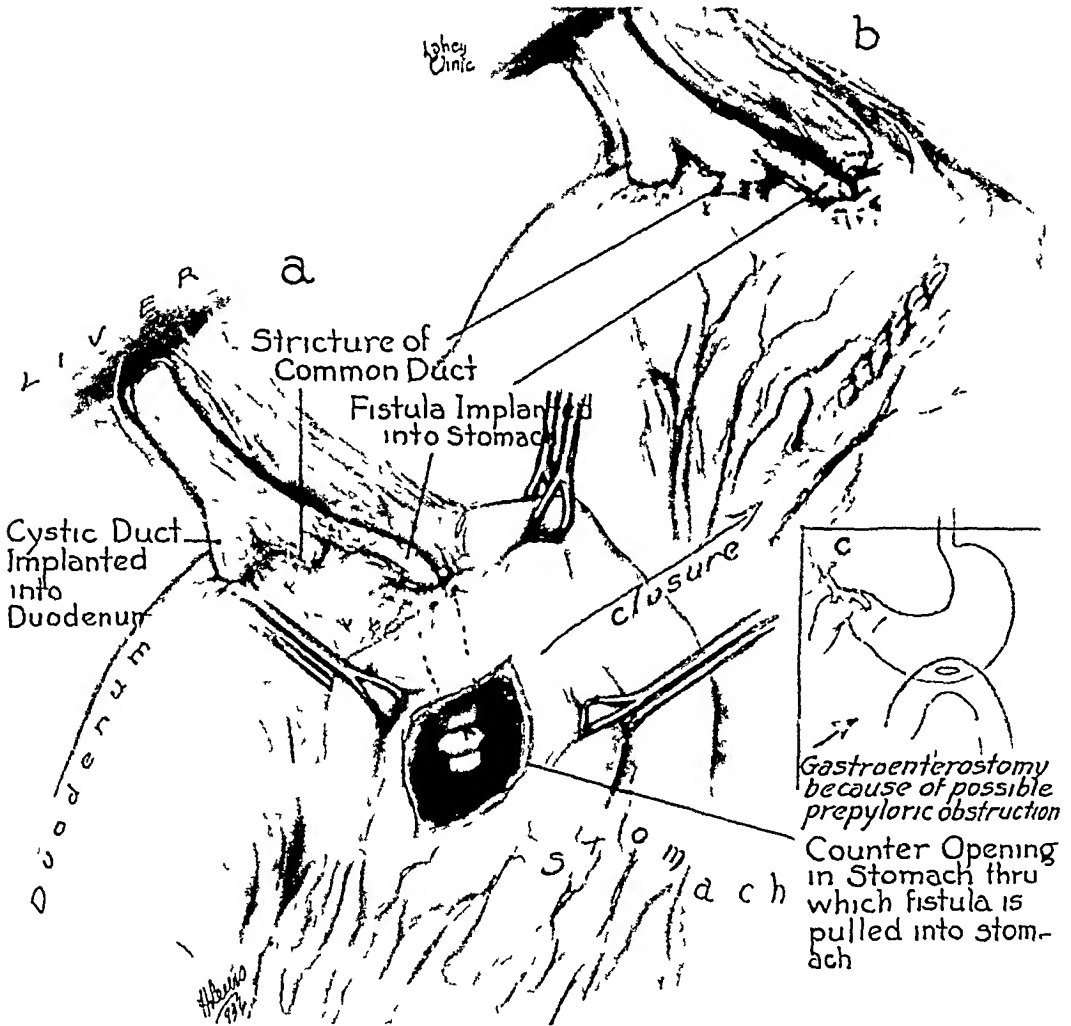


FIG. 17.—Implantation of external biliary sinus into stomach followed by gastro enterostomy

quite impossible and the operation quite probably would have resulted in a fatality.

**SUMMARY**—Nine cases of stricture of the common or hepatic duct are presented. These cases were chosen from a group of such complications because each one was treated by a different plan, selected to meet what appeared to us in each of these cases to be a different problem and also because these procedures have all been, at least so far, successful in overcoming the difficulties.

Based upon a considerable experience with hepatic duct strictures and also a considerable number of failures as well as successes, I would like to submit a few conclusions which I have drawn from our failures as well as our successes

#### CONCLUSIONS

In operating upon common and hepatic duct strictures one should attempt to select the operative procedure which offers the best chance of draining the bile into the intestinal tract at the first operation, as secondary operations after failures upon patients with these lesions are much more complicated and much less likely to be successful

Repairs fashioned after the Heineke-Mikulicz plan in long strictures of the common or hepatic ducts are doomed to failure since there will be too much tension on the sutures in the reconstructed duct. In such cases, anastomosis of the end of the hepatic duct with the duodenum will be a much more satisfactory procedure

<sup>a</sup> If a strictured duct is to be repaired by the Heineke-Mikulicz plan of plastic upon it, the T tube is best inserted through a separate incision in the duct above the stricture, the lower limb of the tube passing through the incised stricture as in Case 6 and the plastic performed over this portion of the tube. This permits withdrawal of the T tube without injury to the line of the anastomosis. End-to-end anastomosis of the common and hepatic ducts will be followed by separation unless there is a good deal of slack in both ends of the ducts and they come together easily. If they do not, it is much better to anastomose the end of the hepatic duct with the duodenum

When the hepatic duct has been cut previously, careful inspection should be made of the amount of hepatic duct available for suture to the duodenum and a decision made as to whether or not a sufficient amount of duct projects from the liver bed so that a safe anastomosis can be effected. This is, in our hands, made easier by the employment of interrupted sutures

When a rubber tube must be implanted as a substitute for a destroyed duct so that it projects into the duodenum, it is less likely to be successful than when it can rest in the hepatic duct and common duct to bridge a defect and not pass to or through the sphincter of Oddi

The implantation of the end of a cut duct with a section of catheter tied in it to prevent its constriction by the purse string suture which holds it in the duodenum will at times, I believe, be safer than direct suture between the end of the duct and the duodenum

The production of an external biliary fistula and its implantation, while an undesirable operation and one in which many failures and recurrences of stricturing will occur, will occasionally need to be practiced as a last resort

Careful preliminary isolation of the cystic artery and its clamping and ligation before the cystic duct is cut in cholecystectomy will prevent most

of the cystic or hepatic artery hemorrhages in cholecystectomy, which in turn will prevent duct injury and the production of duct strictures

Finally, there must be no more distressing situation in surgery than that associated with the production of an hepatic or common duct stricture. There is no result in surgery which is more gratifying than the successful operative relief of this condition and there is no place in surgery where surgical judgment and technical skill can better be exhibited than in the operative management of strictures of the common and hepatic ducts

#### DISCUSSION OF THE PAPERS OF DOCTORS HEUER AND LAHEY

DR ROBERT L. PAYNE (Norfolk, Va.) —I know there are many men here who are far more capable of discussing these papers than I am, but I wish to indulge myself in discussing particularly Doctor Heuer's paper, because of my interest in acute cholecystitis. I do not wish to discuss when to and when not to operate on acute cholecystitis, but to summarize my attitude in saying that, given a case we recognize as acute cholecystitis, if the signs and symptoms are progressive, or if a retrogression in this clinical picture is followed by pain and leukocytosis, I think operation is immediately necessary. In anticipation of this discussion on acute cholecystitis, I hurriedly reviewed 355 gallbladder cases we had operated upon in the last nine years and found that 65 cases were acute cholecystitis, and of those 29 were gangrenous.

I probably feel differently than many of you in that I am strongly opposed to cholecystostomy in acute cholecystitis. I think in that way we have not removed the cause of the trouble and that the further damage to the liver will continue and cause more trouble than operative removal. Gangrene occurred in this group in 8 per cent of the cases, whereas acute cholecystitis was only present in 18 per cent. I do not think any of you would operate on a gangrenous appendix by putting a tube in its lumen and getting out, and I feel that the same applies to acute cholecystitis. We had two deaths in this series but no peritonitis. The only cause of death we could find was acute necrotizing hepatitis and I believe that is what occurs in acute cholecystitis when you do not remove the cause.

I was delighted to hear Doctor Lahey speak of planting tubes in the common duct. I have two patients at present with tubes, that have not come away, in the duodenum. One was a very short anastomosis located just where the common duct emerges from the liver. The anastomosis was effected over a tube and in that case, instead of the tube working down as they usually do, it went up into the liver. It can be seen in the roentgenogram. I hesitate to go in and remove it and wish Doctor Lahey would help me out with some suggestions.

DR FRANK K. BOLAND (Atlanta, Ga.) —Doctor Lahey has described several ingenious and skillfully performed operations for the difficult condition of stricture of the bile ducts. I wish to report a ten year old case of bile duct obstruction caused either by stricture or stone, probably the latter. A few days after removal of the gallbladder for stones, there was a copious flow of bile from the drained wound, soon followed apparently by a discharge of the entire biliary secretion. I thus observed the condition of a patient who was losing all of her bile. Of course the stools were absolutely clay colored. Retention of bile in the system, with jaundice, causes itching, and I learned that absence of bile causes intense, intolerable itching. The



patient's suffering became so severe that she had to be restrained in the bed. She could not eat, vomited incessantly, and became markedly emaciated. The pruritus was especially severe in the mucous membranes, which were vermilion red. I could collect most of the bile through a drainage tube, and attempted to reintroduce it into the patient through a duodenal tube, but she permitted the procedure only once. In those days we were not giving as much saline and glucose as we are today. The patient's condition was so bad that I did not think she would stand any prolonged manipulation to close the biliary fistula, so I adopted the following measure. Under local anesthesia a jejunostomy was performed through the left rectus muscle. I then had a rubber tube leading into the jejunum, and another rubber tube draining bile from the fistula. These two tubes were connected outside the body by a glass tube. I then could observe bile flowing out of the body, and back into the body again. This flow continued for only three days, during which time all the patient's symptoms abated, and she improved rapidly. I then removed the drainage tube, but fed the patient through the jejunostomy tube for ten days, when the tube came away. I cannot tell in what manner this operation helped the patient, except that it preserved her bile, and saved her life. Evidently it removed the obstructing agent, whatever it was. Her weight had dropped to 100 pounds. I saw her a few months ago. She was in good health and weighed 200 pounds.

DR WALFMAN WALTERS (Rochester, Minn.)—These papers on lesions of the biliary tract are outstanding contributions to our knowledge of this field. Time will not permit commenting on more than one of them and so I will confine my remarks to discussing Doctor Lahey's paper.

He is to be congratulated on his choice of surgical procedures employed in the cases which he has presented. The successful result which has followed employment of this variety of surgical procedure in the treatment of stricture of the common bile duct illustrates the fact that each case is an individual problem in which the surgeon is concerned with restoration of continuity between normal tissues beyond the stricture. In my experience the operation of choledochoduodenostomy or hepaticoduodenostomy has given the best results, providing it is possible to make an accurate anastomosis. Yet experience has shown that good results also have been obtained in the few cases in which local excision of strictures has been carried out with anastomosis of the end of the duct in cases in which the stricture was situated so high on the common duct that insufficient duct remained above the stricture to permit choledochoduodenostomy to be performed, because of the inability to mobilize the duodenum satisfactorily, and in some cases of complete stricture of the extrahepatic bile ducts in which external biliary fistulae have been transplanted into the stomach.

In elaborating further on the results following these and other procedures, I think you would be interested to have a later report of the 29 cases of stricture of the common bile duct which I reported before this Society in 1931.

An additional five years have elapsed since that report. My former first assistant, Dr. K. K. Nygaard, now associated with Sembrup, of Oslo, Norway, and I have completed a study of these 29 cases as well as an additional 22 cases upon whom I have operated since that time. In his<sup>1</sup> report he said: "In this series of twenty-nine cases of stricture of the common bile duct in which operation was performed by Walters of The Mayo Clinic there were four deaths in the hospital, or an immediate mortality of 13.8 per cent. By correspondence or reexamination at the Clinic I have been able to get in-

formation regarding the subsequent course of all the other patients. At the time this was written sixteen patients were still living and fourteen of them or about 48.3 per cent of the entire group, were in good physical condition (Table I). One of these patients, a woman who at the time of her operation was thirty-two years of age, went home in excellent condition and went through a perfectly normal pregnancy and delivery one year after operation. Nine patients were found to have died subsequent to operation. From letters received, eight of these deaths appeared to have been directly attributable to the original pathologic lesion in the strictured bile duct and to associated damage to the liver. In one case the cause of death was bronchopneumonia. Ten years was the longest period and twenty months the shortest period that any of these nine patients had lived after operation. The average duration of life was five years and three months. The average age of these nine patients at the time of operation was forty-two years. The normal expectancy of life at this age is eighteen to twenty years. Since the expectancy of life for the group of patients under consideration, if operation had not been performed, was limited, life in these nine cases appears to have been prolonged to about 20 to 25 per cent of the normal expectancy. It is interesting to meditate what this percentage of prolongation of life will be when a full account can be given of the entire group of cases in the future.

TABLE I

RESULTS, AS OBTAINED BY A RECENT FOLLOW UP STUDY OF THE  
29 CASES IN WHICH OPERATION FOR STRICTURE OF THE BILE  
DUCTS WAS PERFORMED PRIOR TO 1933 BY DOCTOR WALTERS

Result	Cases	Per Cent
Deaths in hospital	4	13.8
Subsequent deaths*	9	31.0
Living and in good condition	14	48.3

\* The average duration of life after operation of these nine patients was five years and three months.

"Since January 1, 1932, Dr. Walters has performed operations in twenty-two additional cases of stricture of the bile ducts making a total of fifty-one cases. Of these twenty-two patients, three died in the hospital, giving an immediate mortality of 13.6 per cent which is practically identical with the hospital mortality for the group of patients operated on before 1933. In four of these cases the immediate cause of death was postoperative cholemic hemorrhage. The fifth patient, a woman fifty-two years of age with a complete stricture of the common and hepatic ducts on whom a last stage transplantation of external biliary fistula had been performed, did nicely for one week. On the eighth postoperative day, however, she had a massive hemorrhage necessitating opening and packing of the wound. She never recovered after this and died about two and a half weeks after operation. In the sixth case bleeding from the wound and gastro-intestinal tract was a serious complication during the second postoperative week. The bleeding stopped, however, when the value for blood urea started to increase and edema developed in her extremities. The patient died three and a half weeks after operation from hepatic insufficiency and uremia. The immediate cause of death in the seventh case was hepatic insufficiency.

"It seems obvious, therefore, that the greatest danger in these cases of more or less long-standing stricture of the bile ducts is postoperative cholemic hemorrhage.

"Of the remaining nineteen patients, I have recent information indicating that fifteen, or about 68.2 per cent of the original twenty-two are living and in good condition. Of the remaining four patients, one died at home from abdominal hemorrhage brought about by recurrence of the lesion in the biliary tract and the other three are living but are not in good condition."

#### REFERENCES

- <sup>1</sup> Nygaard, K. K., Shelden, C. H., and Walters, Waltman. Benign Strictures of the Bile Ducts. Results in Fifty-one Operative Cases. Proc. Staff Meet., Mayo Clinic (In press.)
- <sup>2</sup> Walters, Waltman. Resections of the Common and Hepatic Bile Ducts and Ampulla of Vater for Obstructing Lesions. Results in Thirty Cases. Surg., Gynec., & Obstet., 56, 235-241, February, 1933.

DR. RAYMOND P. SULLIVAN (New York, N. Y.)—Stricture of the common or hepatic bile duct, with or without fistula, is a vexatious and important clinical problem because (a) of its own variation in anatomic difficulties and (b) the consequential pathologic changes incident to its presence, prone to affect liver and blood structures. Doctor Lahey has enumerated the fundamental principles involved in the surgical management of these cases. I desire to call attention, by emphasis, to a possibility of reformation of common duct stricture resulting from secondary fibrosis at the site of repair of an original stricture. To illustrate, the appended case is cited.

**Case Report**—A. B., a female, age 33, married, was admitted to St. Vincent's Hospital, New York, July 2, 1931, complaining of recurrent attacks diagnosed, after study, as due to cholecystitis and probable calculi. Cholecystectomy with drainage and appendectomy were performed. The surgeon noted that "Because of the apparent disease of gallbladder, thickened and surrounded by adhesions, and the pouchy condition of the portion near the cystic duct—gallbladder was removed and liver sulcus drained." Postoperative Course. Returned from operation in good condition. Color good. Blood pressure 124/74. Pulse 110. On second postoperative day dressings were soaked with bile, necessitating frequent changes daily. Drain and stitches were all out by the tenth day. By the twenty-first postoperative day, discharge of bile was copious. Stools were clay colored. At this time I saw the patient for the first time, and concurred in the opinion that the biliary fistula was due to common duct injury associated with stricture or impacted calculus. Operation was advised but not accepted until August 26, the forty-eighth postoperative day. Operation, August 28, 1931. The opening from which bile was exuding was located in the portal fissure close to the junction of the left and right hepatic ducts. Slight traction on the fibrous common duct stopped the flow of bile and revealed the opening to be in the right hepatic duct.

The procedure was to excise the stenosed portion of the common duct and to dilate the fistulous opening near the fusion of the hepatic ducts sufficiently to include both hepatic ducts. Then a V shaped flap from the duodenal wall was made in a transverse direction. The apex was fixed to the ductal opening by interrupted sutures on the posterior wall. A T tube was inserted. The margins of the duodenal walls and duct were closed over arms of T tube. The approximation was satisfactory and without tension. Additional drains were placed alongside stem of T tube. Wound was closed. Postoperative course was stormy for three days. Bile passed into the intestinal tract, and was noted in the stool on fifth day. Auxiliary drains and stitches were all out by the twelfth day and progress was satisfactory. The T tube stem was clamped off by rubber band intermittently. General improvement continued. However, on October 10, the intern reported absence of T tube. Roentgenologic examination

revealed the tube in the descending colon, from which it was passed October 14 without distress. The abdominal wound healed rapidly and the patient was discharged October 24, 1931, free of symptoms. She was observed at follow up clinic at regular intervals until January 30, 1932. When seen March 31, 1932, she reported having had an attack of "grippe" five weeks previously—following which she noted beginning jaundice and clay colored stools. She refused operation at this time and was treated medically. However, she was readmitted, May, 1932, and reoperated upon, June, 1932. A definite stricture was found at the site of the previous anastomosis between duct and duodenum. The hepatic duct was now longer than previously. The procedure was to divide the stricture on its anterior aspect leaving the posterior attachment intact. Bile gushed out with considerable force. It was possible to keep the operative field clear by continuous suction. A T tube was inserted into the right hepatic duct and duodenum and reconstruction made over the transverse arms of the tube. Secondary drains were placed to either side of the site of anastomosis and the wound was closed.

The postoperative course was most satisfactory. The jaundice cleared rapidly and the wound healed quickly. All auxiliary drains and stitches were removed on twelfth day. The patient was discharged July 17, 1932, with instructions as to how to manage the T tube stem. On January 23, 1933, or six months postoperatively, the patient had gained 40 pounds and was free from all symptoms of distress. Stools were normal in color and consistency. She now requested removal of T tube, which was done January 25, 1933. She was discharged February 18, 1933, with wound completely healed and no complaints or distress. She was seen at stated intervals with happy reports. When last seen, October 20, 1936, four years after second operation, her condition was satisfactory.

This case illustrates the necessity for accurate anatomic recognition when performing cholecystectomy. Secondly, that injury to the common duct will usually not be recognized at time of operation. Thirdly, that successful reconstruction of the common duct may be followed by secondary stricture.

DR W D HAGGARD (Nashville, Tenn.) —I will speak briefly of a simple and satisfactory method of caring for the cases of gangrene of the gallbladder which are so severe and difficult. They are so water-logged and friable that one has great difficulty in doing a cholecystectomy. These cases give the greatest danger of injury of the ducts because it is so difficult to expose them. Inadequate exposure makes accidents happen. I may say that this method is not original with me but was first suggested by Dr. Denegre Martin and also independently by Doctor Gatch. The object is not to attempt to strip the gallbladder from its bed in the liver, which entails so much bleeding, but instead to remove all of the gangrenous gallbladder, leaving only the healthy posterior wall of the gallbladder in the fossa of the liver. After that, one can destroy the remaining mucosa by one of two methods, either by the use of carbolic acid on a gauze sponge or by means of a cautery. Then one introduces a catheter into the cystic duct for drainage and sutures the healthy cut edge of the wall of the gallbladder over it. This method simplifies and makes possible the quick and safe removal of a gangrenous gallbladder. I wish to commend it as being an excellent way to accomplish what is otherwise a difficult cholecystectomy.

# THE SURGICAL TREATMENT OF CHRONIC BILIARY TYPHOID CARRIERS

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HEALTH, LANSING, MICH

IT is generally agreed that the carrier problem is the most important one remaining in the eradication of residual *Bacillus typhosus* infection. Unfortunately nothing has been accomplished toward preventing a typhoid fever patient from becoming a typhoid carrier, nor, indeed, has much attention been paid to this problem in preventive medicine. Public health practice has concerned itself, instead, with the discovery, control and cure of persons in whom the carrier state has been established.

Since the establishment of typhoid fever stations in Germany at the beginning of the century, many therapeutic agents have been used in the treatment of carriers. Steitenbrink<sup>1</sup> reviewed the literature on the subject and called attention to the many unsuccessful attempts that had been made up until 1928. Furthermore, since then there has been no evidence of an effective curative agent except that of Gulbrandsen,<sup>2</sup> who reported four cures in 12 chronic carriers treated with deep roentgen therapy over the gallbladder. However, Forsbeck and Lampe<sup>3</sup> were unable to effect any cures in a series of cases treated with deep roentgen therapy, although negative specimens became more frequent during treatment in some instances.

In 1888, Anton and Futterer<sup>4</sup> isolated the *B. typhosus* from the gallbladders of fatal typhoid fever cases. Later, in the German carrier campaign it was discovered that the organism could usually be found in the gallbladders of chronic carriers. Indeed, as was pointed out by Malloy and Lawson,<sup>5</sup> in 1931, the persistent infection of the gallbladder in typhoid carriers usually produces a chronic inflammation of that organ which is characteristic though not pathognomonic. It has long been known that cholelithiasis is usually present in chronic typhoid carriers.

In 1908, Gimme<sup>6</sup> reported a cholecystectomy performed for the purpose of curing a carrier. Since that time, this method has become an accepted, though not very common, therapeutic procedure for the cure of gallbladder carriers. In the reference of Senftner and Coughlin<sup>7</sup> to the work of Bergglas<sup>8</sup> and to that of Hage and Binkmann,<sup>9</sup> there is an overcount of operations performed. Of the 74 cases of Bergglas, only two were his own, 66 of the others being those already summarized by Hage and Binkmann.

The benefits of cure by cholecystectomy accruing to the carrier, his family and the community may be summarized as follows

- (1) The occasional case that occurs even after a person knows himself to be a typhoid carrier is prevented
- (2) The former food-handling carrier is able to resume his occupation
- (3) The mental depression frequently observed in carriers is relieved
- (4) Potential or actual gallbladder disease is eradicated
- (5) The health department is released from the expense of controlling a potential source of infection

#### ELIGIBILITY CRITERIA FOR OPERATION AND FOR RELEASE OF CHRONIC BILIARY TYPHOID CARRIERS

*Analysis of Previous Reports*—In the early work subsequent to Gimme's report, neither preoperative nor postoperative bile specimens were obtained, and release following cholecystectomy was based entirely upon the examination of feces. Many carriers were included in these reports who had submitted to operation because of their clinical symptoms but who were not separately classified either as to cure rates or fatality rates. Furthermore, the literature, especially foreign literature, includes many carriers of the paratyphoid group which are not separately analyzed as to fatality rates and cure rates. Finally, many of the reports include, without separate consideration, convalescent carriers who may be positive for only a few months after illness. Such a carrier has an excellent chance of clearing up spontaneously.

We have omitted the early German literature in preparing Table I because, as Bigelow and Anderson<sup>10</sup> have pointed out, the eligibility criteria for operation and release in the earlier work were not up to the present standards. We have excluded paratyphoid carriers, typhoid carriers who have not had at least one release bile specimen in addition to release feces specimens, convalescent carriers, and persons treated otherwise than by cholecystectomy. We have included, however, cases irrespective of whether or not a preoperative bile was obtained. This analysis reduces the number of cases which can be used for a study of the effectiveness of cholecystectomy to a rather meager number.

Omitting our own series, it may be noted that about 62 per cent of all cases were returned to their communities alive and noninfectious. But if only those who were operated upon because they were carriers are considered, it may be noted that about 74 per cent were cured, and omitting the three deaths occurring in the Senftner and Coughlin series, 79.5 per cent of the cases were cured.

*Determination of Gallbladder Infection*—While carriers in whom the only nidus of infection is in the intestinal wall are rare, there is little evidence as to the relative occurrence of this type of carrier. Garbat<sup>11</sup> found one intestinal carrier in 146 convalescent carriers. This, however, cannot be accepted as evidence of the occurrence of intestinal carriers among chronic

carriers\* It was not until after the development of practical duodenal drainage by Einhorn<sup>12</sup> that preoperative bile specimens were commonly obtained During the past ten years, preoperative diagnostic bile specimens have been usually considered prerequisite to operation in chronic carriers essentially free from gallbladder symptoms The procurement of a negative specimen (indicating a negative biliary tract) with positive feces would contraindicate cholecystectomy

It has been shown, by Foisbeck and Hollon,<sup>13</sup> that the reliability of a negative report on a bile specimen depends largely upon the hydrogen ion concentration of the specimen A mixture of gastric juice and bile is usually submitted to the laboratory by the uninitiated Such a specimen is usually highly acid In it the typhoid organisms may be killed in less than 30 seconds after mixture has occurred Consequently, when a negative specimen of "bile" is obtained preoperatively, it must be known definitely that the specimen is actually bile, before the case may be classified as an intestinal carrier

In spite of the rarity of intestinal carriers it is not justifiable to subject a carrier to cholecystectomy without definitely knowing that he is a chronic bile carrier, unless the operation is indicated purely from the clinical viewpoint Recently an illustrative case came to our attention This person, after two positive feces, had a long series of negative feces Without a preoperative bile drainage, she submitted to cholecystectomy on the assumption that she was a carrier No bile was taken for culture at the time of operation The case was probably a contact feces carrier who cleared up spontaneously before the date of operation

On the other hand, intestinal carriers are so rare that for the purpose of analysis we may consider that feces carriers are gallbladder carriers, unless proved to be intestinal carriers by the procurement of a negative diagnostic bile specimen This can, at most, cause but a trifling error in an analysis

*Surgical Risk*—The literature is not clear concerning the mortality rate from cholecystectomy in carriers since it is not always stated whether a carrier submitted to operation mainly to cure his carrier condition, or because of the urgency of his clinical symptoms To deprecate surgical intervention for the cure of the carrier state because of deaths occurring among carriers operated upon because they were seriously ill with gallbladder disease is obviously illogical

In so far as surgical risk is concerned each case must be judged without regard to his carrier state, although the Michigan Department of Health as a matter of public policy does not urge cholecystectomy for any person over 50 without symptoms of gallbladder disease On the other hand, it is considered good surgical practice to urge any good risk with gallbladder pathology to submit to cholecystectomy simply for his own welfare Cholecystitis

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\* Several large states and cities have agreed on arbitrarily declaring those who have harbored the *B. typhosus* for one year or more from date of onset with typhoid fever to be chronic carriers, those for less than one year convalescent carriers

TABLE I  
RESULTS OF CHOLECYSTECTOMIES PERFORMED UPON CHRONIC BILIARY TYPHOID CARRIERS  
*Summarized from Data of Various Authors\**

Author	Year	Percentage of Cures										Mortality Percentage			
		Reason for Cholecystectomy Gallbladder Symptoms or a Carrier					Reason for Cholecystectomy Gallbladder Symptoms or a Carrier					Reason for Cholecystectomy Because a Carrier			
		Recovered or Died		Recovered Cases Only		No Operations	Recovered or Died		Recovered Cases Only		No Operations	Reason for Cholecystectomy Because a Carrier			
		Per Cent	0%	Per Cent	0%		Per Cent	0%	Per Cent	0%		All Ages	Under 50	All Ages	Under 50
		Operations		Operations			Operations		Operations			No Operations	No Operations	No Operations	No Operations
												Per Cent	Per Cent	Per Cent	Per Cent
Haaland and Haaland <sup>15</sup>	1927	1	0%	1	0%	1	0%	0%	1	0%	1	0%	0%	1	0%
Bergglas <sup>8</sup>	1929	2	100%	2	100%	2	100%	0%	2	100%	2	0%	0%	2	0%
Whipple <sup>16</sup>	1929	2	100%	2	100%	2	100%	0%	2	100%	2	0%	0%	2	0%
Vogelsang and Haaland <sup>14</sup>	1931	2	0%	2	0%	2	0%	0%	2	0%	2	0%	0%	2	0%
Seftner and Coughlin <sup>7</sup>	1933	36	50%	28	61.3%	21	66.7%	21	76.2%	21	76.2%	32	0%	12	7.1%
Bigelow and Anderson <sup>10</sup>	1933	8	100%	8	100%	7	100%	0%	7	100%	8	0%	0%	7	0%
Hanssen <sup>17</sup>	1935	4	100%	4	100%	4	100%	0%	4	100%	4	0%	0%	4	0%
Subtotals	1927-1935	55	61.8%	47	72.3%	42	73.7%	39	70.5%	39	70.5%	10	0%	60	5.0%
Coller and Forsbeck	1937	18	88.9%	18	88.9%	16	87.5%	16	87.5%	16	87.5%	15	0%	16	0%
Totals	1927-1937	73	68.5%	65	76.9%	58	77.6%	55	81.8%	55	81.8%	95	0%	76	3.9%

\* In abstracting this material paratyphoid carriers convalescent carriers and persons released without at least one negative bile specimen following cholecystectomy have been omitted



is so nearly universal in chronic carriers and cholelithiasis so common, that for practical purposes it is logical to assume preoperatively the presence of gallbladder pathology. As may be noted in Table I, no deaths have been reported in any series except that of Senftner and Coughlin. In their series the fatality rate was 14.7 per cent for all cases. Of those submitting to cholecystectomy primarily for cure of the carrier state, only three or 7.1 per cent died as a result of the operation. In a personal communication Doctor Senftner has kindly supplied us with the following data concerning these three cases:

Case 1—P. G., male, age 51. Operated upon, September 20, 1929. Died, September 23, 1929, of acute peritonitis.

Case 2—M. G. female, age 57. Operated upon, August 12, 1922. Died, August 12, 1922, of surgical shock and acute dilatation of heart.

Case 3—H. D., female, age 60. Operated upon, June 21, 1932. Died, July 3, 1932, of enterocolitis, toxemia, cholecystitis, cholelithiasis. Convalescing uneventfully until five days after operation.

It may be noted that all these persons were over 50 years of age. Cases 1 and 2 were inmates of state institutions for the insane, persons notoriously of low resistance.

*Percentage of Cure*—In determining the percentage of cure, it is proper to include persons operated upon for clinical symptoms, provided this group is analyzed separately. While not yet proved, it would seem almost a truism, that the severity of clinical symptoms would be correlated with the extent of biliary tract involvement and therefore with the chance of cure. Vogel-sang and Haaland<sup>14</sup> have suggested the probability that the rate of cure depends upon the number of years that the carrier has had gallbladder infection. Two of their carriers, of respectively 17 and 45 years' standing, were not cured by cholecystectomy. Sufficient accumulation of data may enable us to predict fairly closely the probability of cure based upon the duration of the carrier state.

#### PRESENT ELIGIBILITY CRITERIA FOR OPERATION AND RELEASE OF CHRONIC BILIARY TYPHOID CARRIERS IN MICHIGAN

(A) Eligibility criteria for carriers to be operated upon primarily for cure of the carrier state:

- (1) The person must be a chronic carrier.
- (2) The person must be a bile carrier.
- (3) The person must be a good surgical risk.

(B) Eligibility criteria for release after cholecystectomy:

(1) Twelve consecutive feces specimens obtained at monthly intervals following operation and examined in a laboratory approved by the Michigan Department of Health shall be negative.

(2) Two consecutive bile specimens obtained during the year after operation and considered satisfactory for examination by the Michigan Depart-

ment of Health shall be examined in an approved laboratory and found to be negative<sup>1</sup>

*Results of Cholecystectomy in Michigan Series*—Our series of 18 cases has been summarized in Table II. Eleven of these cases were operated upon at the University Hospital †. All cases were chronic carriers. Twelve, or 67 per cent, had slight to marked symptoms of gallbladder disease. In two of these (Cases 5 and 16), operation was performed primarily for the relief of clinical symptoms. No deaths occurred in our series.

Of 11 preoperative bile specimens obtained ten were positive, while of 15 bile specimens obtained at operation 14 were positive. The negative preoperative bile specimen was obtained by an observer unfamiliar with the necessity of securing bile and not a gastric juice-bile mixture. The negative bile specimen obtained at operation was examined in a laboratory which had been doing but little typhoid work. In Case 1, only, it was not definitely proved by a positive bile that the person was a bile carrier. However, the patient was cured by cholecystectomy.

Of the 18 cases, three were males and 15 females. The average age at operation for the males was 35, for females 40.3. The total age incidence was 39.4. Two gave no history of having had typhoid fever. Of those giving a positive history, the duration of infection had varied from one to 38 years, with an average of 15.2 years.

The percentage of cures was 88.9 per cent. Two carriers were still feces-positive, one 14 and the other 15 months after operation. The former (Case 11) had had typhoid fever 28 years before operation, while the latter (Case 13) gave no history of having had the disease. Case 13 is still a biliary tract carrier as indicated by a positive bile obtained 15 months after operation. No postoperative bile has been obtained from Case 11. Case 6, a graduate nurse employed in a hospital, became feces-negative promptly after operation. The first postoperative bile was negative, but this was followed 18 months after operation by a positive finding. Twenty-six months after operation a third bile specimen was negative. During the two years since operation 16 negative feces specimens and no positives have been obtained. The first bile specimen obtained in the hospital where she works was not considered satisfactory by the Michigan Department of Health. We believe that this patient may have been reinfected or that she maintained a slight nidus of infection which was missed in the first bile specimen.

As can be seen in Table II, in most instances the feces became negative within a few days to three weeks after operation. However, the feces may

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\* If further evidence should confirm previously accumulated data,<sup>12</sup> it is probable that the Michigan Department of Health will change the number of negative release biles required from two to one. Already, because of unusual circumstances, two carriers have been released with 12 negative feces and one negative bile.

† We are indebted to Drs. M. J. Darling, W. R. Clinton, and F. B. Wight, of Detroit, F. J. O'Donnel of Alpena, and C. B. Wood of Clare, each of whom has had one case under his care at other hospitals.

BILIARY TYPHOID CARRIERS

Clin  
No  
Sex  
Age  
Oper  
Years  
Since  
1 J

Symptoms Suggesting  
Gallbladder Disease

Gallbladder Pathology

Chronic  
Chole-  
cystitis

Stones

Other

Diagnostic Bilis  
Pre-  
oper  
1 J  
Oper

Bacteriology  
Rel use Specimens

Days  
after  
Oper  
No of  
Negs  
List  
Pos

\* Active chronic purulent cholecystitis

1 V R	F	30	9	Bilious attacks every 3-6 mos from T F to time of oper	None in 10 mos following	Yes	No	—	None	Neg	2	negs	0	13
2 V P	F	26	9	Bilious attacks every 3-6 mos from T F to time of oper	None in 10 mos following	Yes	Yes	—	Pos	Pos	2	negs	308	16
3 F L	F	36	2	Occasional sharp pain and tenderness U R	Occasional sharp pain U R Q since T F	Yes	Yes	—	Pos	Pos	2	negs	04	13
4 A K	F	54	8	Bilious attacks frequently	Pain for past 8 yrs	Yes	No	—	None	Pos	2	negs	04	13
5 L B	F	46	?	Bilious attacks frequently	Recurrent it	Yes	Yes	—	Pos	Pos	2	negs	04	13
6 L H	F	36	13	Bilious attacks frequently	Recurrent it	Yes	No	—	None	Pos	2	negs	04	13
7 C C	F	42	2	Bilious attacks frequently	Recurrent it	Yes	Yes	—	Pos	Pos	2	negs	04	13
8 D S	F	44	36	Severe G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	No	—	None	Pos	2	negs	04	13
9 A W	M	51	16	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
10 T K	M	39	18	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
11 E M	F	39	28	Attack of jaundice 18 yrs ago	None	Yes	Yes	—	None	Pos	2	negs	04	13
12 D W	F	27	2	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
13 G S	F	44	?	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
14 C A	M	15	1	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
15 M J	F	55	38	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
16 G D	F	48	22	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
17 I G	F	33	2	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13
18 T S	F	45	37	Severe acute G B attacks, 1929-1933. Many at- tacks of U R Q pain Occ clay colored	None	Yes	Yes	—	None	Pos	2	negs	04	13

remain positive for a much longer time and eventually become negative, as is shown in Case 2. For two months this patient continued to submit stool specimens in spite of the fact that the specimens remained positive. Because of our inexperience, we were convinced in our own minds that this was to be a failure, however, after 308 days the feces became negative and have remained so.

Twelve patients had symptoms characteristic of cholecystitis or cholelithiasis while the remaining six patients had no symptoms even suggestive of disease of the biliary tract. Gallstones were present in 13 patients and absent in the remainder. There was a nearly uniform finding in the gallbladder on pathologic examination of chronic cholecystitis with marked lymphoid hyperplasia. In two instances, active, chronic, purulent cholecystitis was present and in two cases the gallbladder was greatly enlarged but with the common finding of chronic cholecystitis.

It is worthy of emphasis that a third of the patients had no symptoms referable to the gallbladder, nearly one-third had no stones and the changes in the gallbladder were nearly all minimal in character. In every case, however, there did exist definite changes in the gallbladder characteristic of long standing low grade infection and aside from the cure of the carrier state, so desirable from the public health standpoint, we feel that cholecystectomy will usually improve the health of the patient to such an extent as to make it very much worth while also from the viewpoint of the individual.

#### SUMMARY

(1) In our series, cholecystectomy was performed on 18 chronic biliary typhoid carriers with a percentage of cure of 88.9.

(2) No deaths occurred in the series.

(3) Eligibility for cholecystectomy was based on the carrier being a gallbladder carrier and a good surgical risk.

(4) Cure was considered effected when 12 consecutive negative feces specimens and at least one (usually two) negative bile specimens were obtained.

(5) Most cases become feces-negative in from a few days to two or three weeks after operation. Hope for eventual cure may be maintained for many months, however.

(6) Mortality and cure percentages are comparable only if

a Typhoid and paratyphoid fever carriers are considered separately

b Carriers operated upon primarily for cure of the carrier state and primarily for clinical symptoms are considered separately

c The time elapsed since typhoid fever is taken into consideration

d The criteria for release are identical or at least similar

(7) Cholecystectomy may logically be recommended as a matter of personal precaution to a chronic carrier without clinical symptoms who is a good risk.

(8) Each cure removed one more of a limited number of infection foci and thus contributes to the ultimate eradication of typhoid fever

# REFERENCES

- <sup>1</sup> Stertenbrink, A *Ergebn d inn Med u Kinderh*, 33, 143, 1928
- <sup>2</sup> Gulbrandsen, Lars *Illinois M J*, 67, 262, 1935
- <sup>3</sup> Forsbeck, Filip C, and Lampe, Isadore To be published
- <sup>4</sup> Anton, B, and Futterer, G *Munchen med Wchnschr*, 35, No 19, 315, 1888
- <sup>5</sup> Mallory, T B, and Lawson, G M, Jr *Am J Path*, 7, 71, 1931
- <sup>6</sup> Grimme *Munchen med Wchnschr*, 55, 16, 1908
- <sup>7</sup> Senftner, H F, and Coughlin, F E *Am J Hyg*, 17, 711, 1933
- <sup>8</sup> Bergglas, Bernhard *Wien Arch f inn Med*, 19, 285, 1929
- <sup>9</sup> Hage and Brinkmann *Mitt a d Grenzgeb d Med u Chir*, 37, 25, 1923
- <sup>10</sup> Bigelow, G H, and Anderson, G W *J A M A*, 101, 348, 1933
- <sup>11</sup> Garbat, Abraham L *Monographs of the Rockefeller Institute for Medical Research*, No 16
- <sup>12</sup> Einhorn, Max *Medical Record*, 77, 98, 1910
- <sup>13</sup> Forsbeck, Filip C, and Hollon, Harriett C *Am J Pub Health*, March, 1937
- <sup>14</sup> Vogelsang, T M, and Haaland, Magnus *Norsk mag f laegevidensk*, 92, 1183, 1931
- <sup>15</sup> Haaland, Margit, and Haaland, Magnus *Lancet*, 2, 1172, 1927
- <sup>16</sup> Whipple, A O *ANNALS OF SURGERY*, 90, 631, 1929
- <sup>17</sup> Hanssen, Eilif C *N Y State J Med*, 35, 1206, 1935

# ACUTE PERFORATED APPENDICITIS WITH PERITONITIS

REPORT OF TWO HUNDRED FIFTY-TWO CONSECUTIVE CASES \*

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IN THIS paper, 252 consecutive cases of acute perforated appendicitis treated by members of the surgical department of the Henry Ford Hospital during the years 1915 to 1933 are studied, with special consideration of factors contributing to, and responsible for, the mortality rate. Our experience has been that in 22.1 per cent of patients admitted with acute appendicitis, perforation has occurred.

TABLE I

Type of Peritoneal Involvement	Group	No. of Cases	Percentage of Total Cases	Percentage of Mortality Rate
Local peritonitis	A	55	21.83%	0%
Abscess	B	117	46.43%	4.2%
General peritonitis	C	65	25.79%	21.5%
General peritonitis plus abscess	D	15	5.95%	46.6%
Totals		252	100.00%	10.4%

Of the 252 cases, 21.8 per cent of early perforations were complicated by local peritonitis only, with a mortality rate of zero, 46.4 per cent by circumscribed abscess formation with an operative mortality of 4.2 per cent,

TABLE II

ACUTE APPENDICITIS, 1933-1934

Type	No. of Cases	No. of Deaths	Mortality Rate
Acute diffuse	87	0	0%
Acute diffuse (drained)	25	0	0%
Acute gangrenous (drained)	34	0	0%
Acute perforated with local peritonitis (drained)	26	0	0%
Acute perforated with abscess	22	2	9%
Acute perforated with diffuse peritonitis	11	1	9%
Totals	205	3	1.5%

25.7 per cent by acute spreading or generalized peritonitis with an operative mortality of 21.5 per cent, and 5.9 per cent by both acute generalized

\* Dr. Clyde Allen has operated upon many of these patients and helped with the preparation of the paper.

peritonitis and abscess formation with a mortality rate of 46.6 per cent. The operative mortality of the entire series was 10.4 per cent. Two cases of general peritonitis in extremis were not operated upon, therefore the total mortality was 11.1 per cent. The mortality rate of all cases (205) of acute appendicitis, both ruptured and unruptured, during 1933 and 1934 at this clinic was 1.5 per cent.

Considering the operative mortality rate in the ruptured cases for the five year period from 1915 to 1930, we find that there was a steady decrease from 22.2 per cent to 11.3 per cent. In the period between 1930 and 1934, it had further decreased to 7.7 per cent.

TABLE III  
SHOWING DECREASE OF OPERATIVE MORTALITY RATE DURING  
19 YEAR PERIOD OF RUPTURED APPENDICITIS, 1915-1933\*

Period in Years	No. of Cases	No. of Deaths	Operative Mortality Rate
1915-1919	9	2	22.2%
1920-1924	31	4	12.9%
1925-1929	96	11	11.4%
1930-1934	116	9	7.7%
Totals*	252	26	10.4%

\* A recent survey of 85 cases of acute perforated appendicitis from January, 1934, to June, 1936, shows an operative mortality rate of 4.7 per cent.

**PREDISPOSING ETIOLOGIC FACTORS**—*Sex*—One hundred seventy-one cases, or 68.4 per cent of the entire series, were males and 79 or 31.6 per cent were females, a ratio of slightly more than two to one.

*Age*—Acute appendicitis is usually a disease of young individuals. Between the ages of ten and 30 years is by far the most common period for the initial occurrence of appendicitis. When the four groups of peritoneal involvement are considered separately, however, quite a different picture is obtained. The average age of the local peritonitis group was 27.7 years and the average age of the generalized peritonitis group was 27.5 years. In the group complicated by appendiceal abscess, the average age was 40.3 years and in the group with abscess and generalized peritonitis the average age is 38 years. Thus there is found to be a consistent difference between the average age in the groups with abscess formation on the one hand and in the groups with local and generalized peritonitis on the other hand. The youngest case in the entire series, one of the general peritonitis, was 20 months of age, while the oldest was 81 years of age, having local peritonitis. Both cases recovered after operation.

*Race*—Caucasians comprise the great majority on this series. There were only 29 Negroes, making 11.5 per cent of the total number. Only

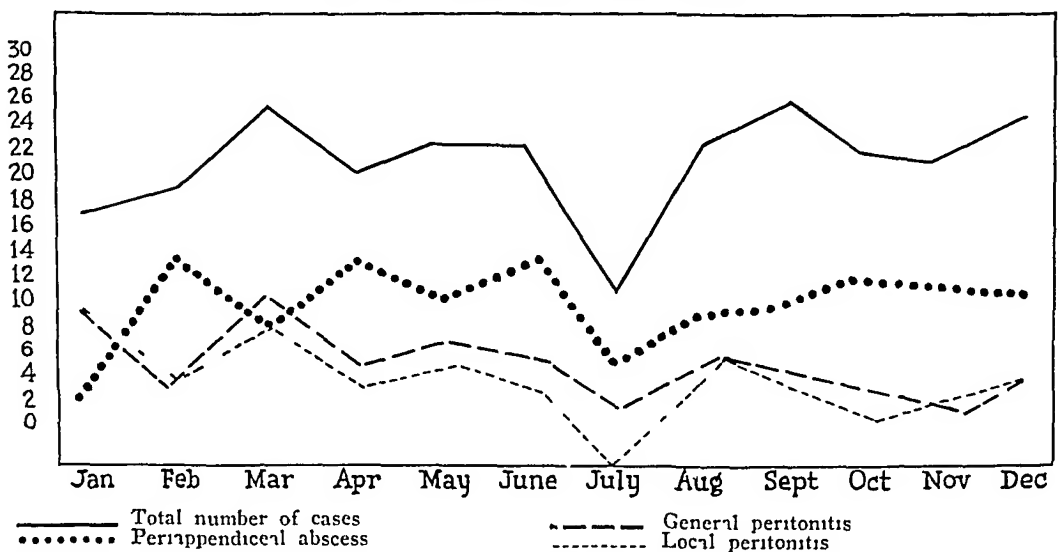
TABLE IV  
AGE DISTRIBUTION OF CASES PRESENTED

Age in Years	General Peritonitis		Abscess		General Peritonitis and Abscess		Local Peritonitis	
	No of Cases	Per Cent	No of Cases	Per Cent	No of Cases	Per Cent	No of Cases	Per Cent
1-10	7	39.0	12	24.0	1	13.3	5	30.9
11-20	18		17		1		12	
21-30	14	49.0	22	63.0	2	66.6	18	61.9
31-40	8		27		6		15	
41-50	10		24		2		1	
51-60	7	12.0	8	12.0	2	20.0	1	7.2
61-70	1		6		1		0	
71-80	0		1		1		0	
81-90	0		0		0		1	
Totals	65	100	117	100	15	100	55	100

one member of the Mongolian race is found in the entire series. Twenty-seven nationalities are represented, namely, American, Polish, Scotch, Chinese, Canadian, French, Swedish, Armenian, Jugo-Slav, Italian, Roumanian, German, Lithuanian, English, Austrian, Arabian, Russian, Irish, East Indian, Hindu, Greek, Finnish, Dutch, Danish, Mexican, Maltese and Syrian.

*Season*—The greatest number of cases occurred in the months of March, August, September and December, although the cases were fairly well dis-

TABLE V  
SHOWING SEASONAL INCIDENCE CURVES OF THE THREE GROUPS OF PERITONEAL INVOLVEMENT



tributed throughout the entire year. There was a uniform and definite remission in the number of cases of general peritonitis, local peritonitis, and abscess in July.



# PERFORATED APPENDICITIS

EXCITING FACTORS—*Foreign Bodies*—The presence of fecaliths was noted in most of the cases with appendiceal abscesses and thus undoubtedly was responsible for the development of the well named obstructive appendicitis. One case at operation presented a straight pin surrounded by hard calcified material lying within the appendiceal lumen having ulcerated through the wall of the appendix into the peritoneal cavity, causing an abscess. In other instances, a hard irregular fecalith had perforated the coats of the appendix and, although the main body still remained within the lumen, small projections from the fecalith presented through one or more small perforations.

TABLE VI

SHOWING THE ORGANISMS CULTURED FROM PERITONEAL PUS AT OPERATION OR AUTOPSY IN 198 CASES OF PERFORATED APPENDICITIS. NO BACTERIOLOGIC REPORT WAS AVAILABLE IN 54 CASES

Organism	Local Peritonitis No of Cases	General Peritonitis No of Cases	Abscess No of Cases	General Peritonitis and Abscess No of Cases	Total No of Cases
<i>B. coli</i>	28	41	78	7	154 or 77.7%
Short-chained gram-positive nonhemolytic streptococcus often showing diplo-forms	4	8	29	2	43 or 21.7%
Large gram-positive bacillus	1	3	4	0	8 or 4.0%
<i>B. pyocyaneus</i>	0	2	2	0	4 or 2.0%
<i>Streptococcus viridans</i>	1	0	3	0	4 or 2.0%
Hemolytic <i>Streptococcus</i>	0	0	2	0	2 or 1.0%
<i>B. paratyphosus</i>	0	1	0	0	1 or 0.6%
Diphtheroid	0	1	0	0	1 or 0.6%
Friedlander's bacillus	1	0	0	0	1 or 0.6%
<i>M. catarrhalis</i>	0	1	0	0	1 or 0.6%
Unidentified gram-negative bacillus	0	0	1	0	1 or 0.6%
Negative cultures	8	5	11	2	26 or 13.1%

*Hematogenous Infection*—Appendiceal infection is sometimes of hematogenous origin. The association of appendicitis with influenza is well known, having been proved by epidemics, notably that of 1918. Appendicitis immediately following acute upper respiratory infections certainly occurs. Acute attacks occasionally occur immediately after removal of badly infected tonsils. In these hematogenous infections, the invading organism is usually the *Streptococcus* and less often the *Staphylococcus*. Rosenow has shown selective affinity in some strains of *Streptococci* for the appendix when inoculated into rabbits. In this particular series 91 per cent of our total cases were immediately preceded by acute upper respiratory infections. The

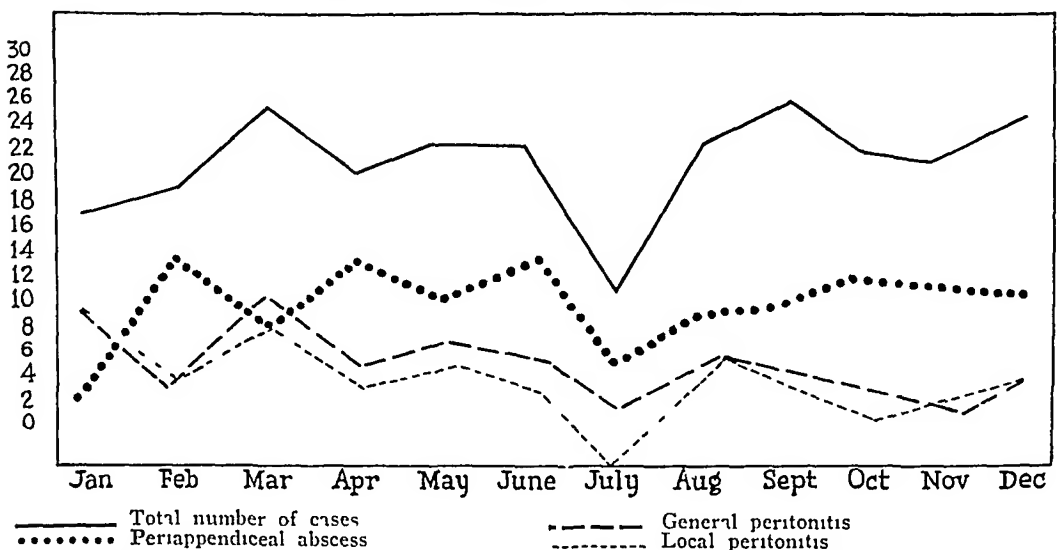
TABLE IV  
AGL DISTRIBUTION OF CASES PRESENTED

Age in Years	General Peritonitis		Abscess		General Peritonitis and Abscess		Local Peritonitis	
	No of Cases	Per Cent	No of Cases	Per Cent	No of Cases	Per Cent	No of Cases	Per Cent
1-10	7	39 0	12	24 0	1	13 3	5	30 9
11-20	18		17		1		12	
21-30	14	49 0	22	63 0	2	66 6	18	61 9
31-40	8		27		6		15	
41-50	10		24		2		1	
51-60	7	12 0	8	12 0	2	20 0	1	7 2
61-70	1		6		1		0	
71-80	0		1		1		0	
81-90	0		0		0		1	
Totals	65	100	117	100	15	100	55	100

one member of the Mongolian race is found in the entire series. Twenty-seven nationalities are represented, namely, American, Polish, Scotch, Chinese, Canadian, French, Swedish, Armenian, Jugo-Slav, Italian, Roumanian, German, Lithuanian, English, Austrian, Arabian, Russian, Irish, East Indian, Hindu, Greek, Finnish, Dutch, Danish, Mexican, Maltese and Syrian.

*Season*—The greatest number of cases occurred in the months of March, August, September and December, although the cases were fairly well dis-

TABLE V  
SHOWING SEASONAL INCIDENCE CURVES OF THE THREE GROUPS OF PERITONEAL INVOLVEMENT



tributed throughout the entire year. There was a uniform and definite remission in the number of cases of general peritonitis, local peritonitis, and abscess in July.

# PERFORATED APPENDICITIS

**EXCITING FACTORS—*Foreign Bodies***—The presence of fecaliths was noted in most of the cases with appendiceal abscesses and this undoubtedly was responsible for the development of the well named obstructive appendicitis. One case at operation presented a straight pin surrounded by hard calcified material lying within the appendiceal lumen having ulcerated through the wall of the appendix into the peritoneal cavity, causing an abscess. In other instances, a hard irregular fecalith had perforated the coats of the appendix and, although the main body still remained within the lumen, small projections from the fecalith presented through one or more small perforations.

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Hemolytic <i>Streptococcus</i>	0	0	2	0	2 or 1.0%
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**Hematogenous Infection**—Appendiceal infection is sometimes of hematogenous origin. The association of appendicitis with influenza is well known, having been proved by epidemics, notably that of 1918. Appendicitis immediately following acute upper respiratory infections certainly occurs. Acute attacks occasionally occur immediately after removal of badly infected tonsils. In these hematogenous infections, the invading organism is usually the *Streptococcus* and less often the *Staphylococcus*. Rosenow has shown selective affinity in some strains of *Streptococci* for the appendix when inoculated into rabbits. In this particular series 9.1 per cent of our total cases were immediately preceded by acute upper respiratory infections. The

mortality rate of this group was 12 per cent, two of the cases being fulminating. The onset of acute appendicitis four and five days following tonsillectomy occurred in two cases. One of these cases was fatal.

*Focal Infection*—Evidence of focal infection elsewhere in the body was found in 92.3 per cent of the total number of cases. Thirty-six per cent of the cases had dental caries, 34.2 per cent had chronic tonsillitis, 20 per cent had gross pyorrhea, and 9.1 per cent had acute upper respiratory infections.

*Trauma*—Many cases of acute appendicitis have been attributed to trauma. It is very doubtful whether the appendix can be injured by any trauma to the abdominal wall. One man in this series received an injury to his right side and abdomen. Following the injury, cramping abdominal pain began in umbilical region with associated nausea but no vomiting. He was unable to sleep and took castor oil. Five days later, he was admitted to the hospital and an acute gangrenous appendicitis with perforation and abscess formation was found at operation. This patient had had no history of attacks of appendicitis previously.

*Catharsis*—Twenty-nine point seven per cent of the cases that perforated were given a cathartic prior to hospitalization either by some member of the family or by their physician. Bowers had shown that of those patients with acute appendicitis who took no cathartic, only one in 80 died, of those who took one cathartic, one in 13 died, while of those who took two or more cathartics, one in seven died. In this series of those who took no cathartics, one in 15 died, of those patients who took one cathartic, one in 10.5 died, of those who took two or more cathartics one in 5.5 died.

Diabetes mellitus was present in seven cases and three of these patients died.

*Opiates*—Morphine had been given before hospitalization of the patient in only five cases, or 1.9 per cent, by the family physician. In each instance, a delay in hospitalization and operation occurred.

*Bacteriology*—Appendicitis is essentially an inflammation of the appendix due to a bacterial infection regardless of its mode of origin. The appendiceal wall becomes invaded either by organisms present in the appendiceal lumen through some traumatized area in the mucosa, or by organisms carried to it by the blood stream. Of the infecting organisms, investigators have found *B coli* in pure or mixed culture the most constant. It is to be remembered that *B coli* is not the only agent causing a putrid odor in peritonitis, the anaerobic organisms, especially anaerobic *Streptococcus putrificus*, being at least partly responsible in many instances. It has been pointed out by Schottmuller, Frankel and others that some of these anaerobes tend to cause thrombophlebitis in any portion of the body they invade. Witness the presence of the *Streptococcus putrificus* in thrombophlebitis of the internal jugular vein complicating peritonsillar abscess and less often in pyelophlebitis.

# PERFORATED APPENDICITIS

complicating appendicitis In appendicitis pus, Brutt found anaerobic Streptococci and *B coli* in 45 cases, *B coli* in pure culture in 36, *B coli* and other aerobes in eight in a series of 107 cases In the same series, purulent putrid pus in 15 instances yielded no organisms on culture

In our series, *B coli* was found in either pure or mixed cultures in 77.7 per cent of the cases Nonhemolytic, gram-positive, short-chained cocci (aerobic), often with many of the organisms appearing in diplo-forms were found in 21.7 per cent of the cases

*Pathology*—The pathology reports show acute gangrenous appendicitis to be the most frequent in this series as well as the most serious In almost 32 per cent of the cases, the appendicitis was described by Dr. Frank Hartman as "acute gangrenous" One-half of these fatal cases (46.4 per cent) had gangrenous appendices The seriousness of the acute gangrenous appendicitis is evident in the fact that it was present in 46.0 per cent of those cases with generalized peritonitis, and in 68.7 per cent of the fatal cases of general peritonitis

TABLE VII

SHOWING PATHOLOGIC TYPES OF APPENDICITIS MORTALITY IN 224 CASES NO PATHOLOGIC REPORT WAS AVAILABLE IN 28 CASES, AMONG WHICH THERE OCCURRED SIX DEATHS IN 19 OF THESE CASES THE APPENDIX HAD NOT BEEN REMOVED AT OPERATION

Pathologic Report	Local Peritonitis		Generalized Peritonitis		Appendiceal Abscess		Abscess and General Peritonitis	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Acute gangrenous	15 (28.8%)	0	29 (68.7%)	11 (68.7%)	27 (27.8%)	2 (40.0%)	0	0
Acute diffuse	15 (28.8%)	0	12 (19.0%)	1 (6.2%)	15 (15.4%)	0	0	0
("Just") Acute appendicitis	14 (26.9%)	0	10 (16.0%)	1 (6.2%)	38 (37.0%)	1 (20.0%)	8 (11.5%)	3 (12.8%)
Acute ulcerative	1 (1.9%)	0	5 (8.0%)	0	4 (4.0%)	0	0	0
Acute exacerbation of chronic	5 (8.6%)	0	5 (8.0%)	1 (6.2%)	11 (11.0%)	0	3 (23.0%)	1 (11.3%)
Acute purulent	0	0	2 (3.0%)	0	0	0	0	0
Subacute	1 (1.9%)	0	0	0	3 (3.0%)	0	1 (7.7%)	1 (11.3%)
Chronic necrotic (caused by a straight pin)	0	0	0	0	1 (1.0%)	0	0	0
Acute hemorrhagic	1 (1.9%)	0	0	0	0	0	1 (7.7%)	0

*Symptoms*—The typical illness with a history of acute appendicitis with the history of cramping epigastric or umbilical pain followed by nausea vomiting, and localization of a dull aching pain in the right lower quadrant of the abdomen is easily diagnosed However, many cases present atypical clinical pictures, and these, consequently, often are not recognized until perforation and peritonitis have occurred In the experience of Elhason and

Johnson about 25 per cent of the cases of appendicitis were atypical in that one or more of the so called "cardinal findings" of acute appendicitis were absent

TABLE VIII

Pathologic Type of Appendicitis	Total No of Cases	Mortality
(1) Acute gangrenous	71 (31.7%)	13 (46.4%)
(2) Acute diffuse	42 (18.8%)	1 (3.5%)
(3) ("Just") Acute appendicitis	68 (30.3%)	5 (17.8%)
(4) No report given (no specimen)	28 (11.1%)	6 (21.4%)
(5) Acute ulcerative	10 (4.4%)	0
(6) Acute exacerbation of chronic	24 (10.6%)	2 (7.1%)
(7) Acute purulent	2 (0.9%)	0
(8) Subacute	5 (2.2%)	1 (3.5%)
(9) Chronic necrotic	1 (0.4%)	0
(10) Acute hemorrhagic	1 (0.4%)	0
Totals	252 (100%)	28 (100%)

In our series of acute perforated appendicitis only 40.7 per cent gave a history of clamping epigastric or umbilical pain, nausea, vomiting and localization of the pain to the lower right quadrant. This figure is considerably lower than those reported for acute unruptured appendicitis. Thus it is evident that the number of atypical cases is much greater in perforated appendicitis. Our attention must therefore be turned to a study of these atypical cases which comprise 59.3 per cent of the total in an effort to learn how better to diagnose them.

Constipation is frequently associated with appendicitis. However enteritis with diarrhea may clear up but still leave an acute inflammation of the appendix. Diarrhea occurred in 6.25 per cent of the series and in 9.07 per cent of those cases complicated by general peritonitis. Seventy-five per cent of the cases with diarrhea occurred in children under ten years of age. The diarrhea was described as from two to 20 green, watery, foul stools daily. One patient with general peritonitis gave a history of a frequent urge to defecate without ability to do so. The presence of diarrhea delayed the diagnosis and operation from one to seven days. Initial back pain occurred in one instance in the absence of umbilical or epigastric pain. Nausea, vomiting and localization of pain to the lower right quadrant followed. At operation, a ruptured appendix with generalized peritonitis was found. This patient expired four days after operation with a paralytic ileus and myocardial failure. Relatively mild chills occurred in only a small number of the acute gangrenous appendicitis cases. Severe chills or rigors, associated with jaundice, occurred in two cases, both with pyelophlebitis.

Only 67 of the 252 cases (26.0 per cent) gave a history of one or more

previous attacks of appendicitis, the distribution in the four groups being approximately equal. It is noted that these cases were liable to early perforation, frequently in less than 24 hours. Perforation of the appendix was found to have occurred within 24 hours or less from the onset of symptoms in one-third of all those cases with a history of previous attacks. Three cases had perforated within six, eight and ten hours respectively. The present illness of those cases perforating before 24 hours was characterized by a more stormy course with severe sudden epigastric or umbilical pain, nausea, vomiting, mild chilly sensations, and localization of the pain in the right lower quadrant. Sudden cessation of the pain was noted in only a few instances.

The average duration of symptoms before operation was 2.5 days for those cases with general peritonitis, 2.8 days for those with local peritonitis, 11.6 days for those with abscess and 6.56 for those with abscess and general peritonitis. It is interesting to note that the average duration of symptoms in both the local and general peritonitis cases is practically the same. This suggests that the type and virulence of the invading organisms and the resistance of the host are important factors determining whether the peritonitis is confined to the right iliac fossa, or becomes quickly disseminated.

*Signs*—Right lower quadrant tenderness was the most constant finding being definitely elicited at the time of admission in 70 per cent of the total number of cases. Complete absence of all signs was recorded in only one instance, one of appendiceal abscess. Suprapubic tenderness was noted in two cases of appendicitis with pelvic abscess. A limping gait was the symptom causing one patient to seek medical advice in one instance of peri-appendiceal retroperitoneal abscess of one month's duration. Jaundice occurred in only two cases, both having pyelophlebitis with multiple liver abscesses.

The average admission temperature for the abscess, local peritonitis, abscess plus generalized peritonitis, and general peritonitis groups are 99.9°, 101.1°, and 100° and 101.2° F respectively. Higher temperatures up to 104 occurred frequently in general peritonitis, and to a lesser extent in appendiceal abscess. The mean temperature corresponds in all instances with the average temperature.

*Laboratory Data*—Urine. Almost one-half (42.2 per cent) of all the cases of acute perforated appendicitis showed an albuminuria. The toxemia, resulting from the appendicitis and peritonitis and causing cloudy swelling of the kidneys, appears to be the explanation for these urinary findings. However, actual infection of the urinary tract may play a definite rôle in many of these cases.

In one instance, the patient, a young girl, was known to have had a definite pyelitis of long standing. She was submitted to the hospital for what was thought to be an acute exacerbation of this condition. A careful history revealed that the attack was ushered in by epigastric cramps, nausea, and

localization of the pain to the right lower quadrant and flank. Although the patient had urinary frequency and burning, and although the urine was filled with clumped pus cells, a diagnosis of acute appendicitis was made. Immediate operation revealed a perforated gangrenous appendicitis with local peritonitis.

The urinary findings in these cases usually cleared up within three to seven days after operation.

The average white blood counts in the four groups were as follows: (1) Local peritonitis, 17,000, (2) general peritonitis, 18,150, (3) abscess, 16,600, (4) abscess and general peritonitis, 14,462. In the general peritonitis group, the lowest white blood count was 10,550 and the highest 53,600. In the local peritonitis the lowest was 8,300 and the highest 30,000. In the abscess group, the lowest was 8,400 and the highest 44,000.

The average differential white blood counts were approximately the same, showing 83.1 per cent polymorphonuclear leukocytes in the abscess cases, 84.4 per cent in the local peritonitis cases, and 85.7 per cent in the general peritonitis cases. The highest individual percentage of polymorphonuclear leukocytes was 98 per cent occurring in a patient with general peritonitis.

*Time of Operation*—There has been considerable controversy among surgeons as to the proper time to operate in acute perforated appendicitis. It is uniformly agreed that all early cases should undergo immediate operation. Concerning those patients who enter the hospital three, four or more days after the onset of symptoms, the disagreement arises as to whether immediate operation should be performed or Ochsner's conservative treatment instituted. It has been the rule in our clinic to operate immediately after the diagnosis of acute appendicitis has been made regardless of the duration of symptoms unless the patient is practically moribund.

*Preoperative Treatment*—Preoperatively, if the patient shows signs of

TABLE IX

SHOWING THE RELATIONSHIP OF THE TYPE OF ANESTHETIC AND MORTALITY

Anesthetic	Local Peritonitis		General Peritonitis		Appendiceal Abscess		General Peritonitis Abscess		Total No. of	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Spinal	6	0	9	1 (11.0%)	12	0	0	0	27	1 (3.7%)
Ether and ethylene	36	0	33	7 (21.2%)	84	4 (4.7%)	10	6 (60.0%)	163	17 (10.3%)
Straight ether	8	0	17	5 (29.4%)	18	1 (5.5%)	4	1 (25.0%)	47	7 (15.0%)
Nitrous oxide and ether	2	0	2	1	2	0	1	0	7	1
Avertin and ethylene	2	0	1	0	0	0	0	0	4	0
Local	1	0	1	0	0	0	0	0	2	0
Totals	55	0	63	147	117	5	15	7	250	26

NOTE: Two cases of patients with general peritonitis in extremis were not operated upon. Both died.



toxemia or dehydration, he is given adequate intravenous (glucose-saline) fluids

The types of anesthesia used are set forth in Table IX

TABLE X

SHOWING THE RELATIONSHIP OF TYPE OF APPENDICECTOMY INCISION AND THE MORTALITY

Type of Incision	Local Peritonitis		Generalized Peritonitis		Appendiceal Abscess		General Peritonitis and Abscess		Total Cases	Total Mortality
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths		
Gridiron or McBurney	40 (72.7%)	0	41 (65.0%)	6 (15.0%)	85 (72.6%)	3 (3.5%)	9 (3.5%)	2 (22.0%)	175 (70.0%)	11 (6.2%)
Right rectus	13 (23.6%)	0	19 (30.1%)	6 (31.6%)	25 (21.3%)	1 (4.0%)	6 (40.0%)	5 (83.3%)	63 (25.2%)	12 (19.4%)
'Midline' suprapubic	2 (4.4%)	0	3 (4.7%)	2 (66.0%)	6 (5.1%)	1 (16.6%)	0	0	11 (4.4%)	3 (27.2%)
Hermiotomy (muscle taken diagonally)	0	0	0	0	0	0	0	0	1 (4%)	0
Totals	55	0	63	14	117	5	15	7	250 (100%)	26

NOTE: Two cases of general peritonitis in extremis were not operated upon

The gridiron or McBurney incision was used in 70 per cent of the total number of cases, the right rectus in 25.2 per cent, and the midline suprapubic in 4.4 per cent. The mortality rate in all the cases operated upon through a McBurney incision was 6.2 per cent, that of those operated upon through a right rectus incision was three times as great or 19.4 per cent, while that of those who had the midline suprapubic incision was over four times as great, or 27.2 per cent. Although this is a rather small series of cases, this is nevertheless evidence showing a definite progressive increase in mortality as the location of the incision is moved from the McBurney site toward the midline. In the local peritonitis group, there were no fatalities regardless of the type of incision used. It would seem that the gridiron incision is the incision of choice in acute appendicitis, ruptured or unruptured, and at any age.

The following advantages of the McBurney incision have been advanced

- (1) Relatively simpler procedure requiring less time
- (2) The appendix or appendiceal abscess is usually easily accessible
- (3) Soiling of the small intestine and other parts of the peritoneal cavity is reduced to a minimum
- (4) Mortality is decidedly lower
- (5) Shorter period of hospitalization
- (6) Elimination of traumatizing effect of gauze packing on intestines and peritoneum with subsequent formation of adhesions
- (7) McBurney incisions, even with prolonged drainage, are less apt to allow the formation of postoperative ventral herniae

The usual operative procedure in our clinic consisted in the removal of the appendix in every instance in which the patient's condition was felt to warrant it. The usual appendicectomy included ligation and inversion of the stump. The appendix was ligated only, and not inverted, in 31 cases: two of general peritonitis, 23 of abscess, four of local peritonitis and two of abscess and general peritonitis. The two cases of general peritonitis and two cases with abscess died.

The appendix was not removed in 19 cases: 17 of abscess with one death, and two of general peritonitis with two deaths. Of the surviving 16 abscess cases in which drainage only was done, four (25 per cent) had a subsequent acute attack of appendicitis proved by operation within one year. A fifth case, having right lower quadrant pain, was operated upon six months after his initial operation and an active "chronic" appendicitis was found. Thus the mortality rate in those patients in whom the appendix was not removed was 15.8 per cent compared to 9.99 per cent for those cases in which appendicectomy was performed. It may be assumed that the patients in whom the appendix was not removed were more ill than in that group in which it was removed.

*Drainage*—Every case in this series was drained with one to three cigarette drains, usually through the original incision. In the more recent cases of general peritonitis, drainage was frequently effected through a right McBurney incision, a left lower quadrant stab wound or a suprapubic stab wound.

*The Average Duration of Operation Was*

43.3 minutes for general peritonitis

47.8 minutes for local peritonitis

45.0 minutes for abscess

58.5 minutes for abscess and general peritonitis

*Postoperative Treatment*—After operation, immediate transfusion is performed on practically all patients with general peritonitis and on many of those with abscess. The tonus of the intestines is kept up with repeated interval doses of pituitrin or pitressin, hot abdominal stupes or intravenous injections of hypertonic salt solution. If this is accomplished, the patient is allowed fluids by mouth. Liquids were withheld only in the instance of vomiting or an ileus.

Postoperatively, the patients receive on an average of 3,000 to 5,000 cc of fluid by oral, intravenous, hypodermoclysis or proctoclysis administration. If there was a tendency to distention, the Rehfuess duodenal tube was used.

*Postoperative Course*—The temperature usually rose on the first day to 101° F, and fell gradually to normal some time on the third day in the great majority of cases. After the third day, the temperature was of an irregular remittent type, rising every afternoon, with the daily peak falling gradually to normal, some time between the eighth and twenty-eighth day,

dependent upon the extent of the infection and the adequacy of the drainage. The cases of general peritonitis tended to run a more prolonged period of fever with higher peaks and lasting on an average of 12 to 20 days. The abscess cases, when well drained, usually ran a febrile course of six to 12 days. The local peritonitis cases usually were afebrile after the eighth or twelfth day. In the fatal cases of peritonitis, the temperature rapidly rose to a terminal level of  $106^{\circ}$  F. or more.

In the general peritonitis and abscess group, two types of temperature curves were found, depending upon whether a general peritonitis or abscess was found at the time of operation. In those patients in whom an abscess was found at operation and in whom general peritonitis later developed, the temperature was found to follow the usual curve, reaching normal on the third day. Thereafter the fever became remittent with high peaks of  $103^{\circ}$  or more, gradually receding to normal in 12 to 20 days. In the fatal cases, the temperature continued to rise after the third day to a terminal level of  $106^{\circ}$  or more. In those patients in whom a general peritonitis was found at operation and in whom one or more intra-abdominal abscesses appeared later, the temperature curve followed the usual curve until the eighth to tenth day when it rose to  $103^{\circ}$  or more, heralding the presence of the abscess.

As a rule, the pulse curve followed that of the temperature. A pulse of

TABLE XI

SHOWING THE IMMEDIATE CAUSES OF DEATH IN THE FATAL CASES. PNEUMONIA, PARALYTIC ILEUS AND CIRCULATORY COLLAPSE COMBINED 54 PER CENT OF THESE CAUSES OF DEATH

Immediate Cause of Death	General Peritonitis	Appendiceal Abscess	Appendiceal Abscess and General Peritonitis	Total No of Deaths	Percentage of Total Mortality
(1) Pneumonia	4	0	1	5	18.0
(2) Ileus	2	0	3	5	18.0
(3) Myocardial failure	4	0	1	5	18.0
(4) Fulminating general peritonitis	3	0	0	3	10.7
(5) Pyelophlebitis	0	2	0	2	7.0
(6) Subphrenic abscess	1	0	0	1	3.5
(7) Septicemia	1	0	0	1	3.5
(8) P. O. Shock	0	0	1	1	3.5
(9) Intra-abdominal hemorrhage, 9 days post-operatively	1	0	0	1	3.5
(10) Mechanical intestinal obstruction	0	1	0	1	3.5
(11) Status thymicolymphaticus	0	1	0	1	3.5
(12) Ruptured wound	0	0	1	1	3.5
(13) Undetermined	0	1	0	1	3.5

140 or greater was a grave prognostic sign, reflecting the severity of the infection or some complication

*Postoperative Complications*—Paralytic ileus occurred in 14 cases, eight with general peritonitis, two with abscess, three with both general peritonitis and abscess, and one with local peritonitis. Nine of these patients died. The frequency and high mortality of this complication bespeak its gravity and the necessity for its prevention. Bronchopneumonia occurred in nine instances with five deaths. Five cases of general peritonitis developed subphrenic abscess, one of which died. Fecal fistulae developed in five patients, one of which died. Myocardial failure was responsible for three deaths in patients with generalized peritonitis. Pyelophlebitis with multiple liver abscesses occurred in two cases, both of whom died, the condition not being definitely recognized before the autopsy. Two cases were known to be complicated by septicemia and one of these recovered. Profound postoperative shock was described in one fatal case with general peritonitis following the appendiceal abscess.

*Sequelae*—Postoperative ventral herniae developed in 46 per cent of the surviving general peritonitis cases, 44 per cent of the surviving abscess cases, 18 per cent of the local peritonitis cases. This herniation occurred in a McBurney incision in each instance but one—a midline incision. It is to be remembered that drainage was used through all of these incisions. Only two cases of general peritonitis, one with a McBurney and one with a right rectus incision, developed acute mechanical intestinal obstruction. This occurred in each instance within one month after operation.

*Period of Hospitalization*—The average period of hospitalization was 22.9 days for local peritonitis, 25.3 days for general peritonitis, 23.8 days for abscess, 26.4 days for general peritonitis with abscess. The duration of stay in the hospital ranged from 11 to 90 days.

**SUMMARY**—The report of this series of 252 consecutive cases of perforated appendicitis shows a steadily declining death rate.

We believe that these improved results are due primarily to better pre- and postoperative handling of the cases. This includes

- (1) Preoperative intravenous fluids
- (2) Repeated blood transfusions
- (3) The use of the duodenal suction drainage tube
- (4) The administration of morphia and pitressin to keep up the intestinal tone
- (5) The maintenance of adequate postoperative fluid intake, either the continuous drip method or by frequent intravenous injections
- (6) Proper psychotherapy by all who come in contact with such potentially ill patients

We also attribute this reduction in the death rate of cases of perforated

appendicitis to such factors as the routine use of the McBurney incision and to the employment of spinal anesthesia unless contraindicated

Recently we have grouped as donors any of those patients who have recovered from peritonitis

The average age of the group of patients with local peritonitis was 27 years while 40 years was the average age of the group who developed abscesses. From this, one might conclude that the Ochsner method of treatment, if it were used, would be safer in the older group of patients

We have not used enterostomy because we believe that all the benefits accruing from its use may be obtained by duodenal suction

#### REFERENCES

- <sup>1</sup> Behan, R. J. Traumatic Appendicitis. *ANNALS OF SURGERY*, 85, 263-268, February, 1927
- <sup>2</sup> Bissell, A. H. Trauma as a Factor in Acute Appendicitis. *Arch Surg*, 17, 672-675, October, 1928
- <sup>3</sup> Black, C. E. Appendicitis Statistics. *West J Surg*, 40, 176-187, April, 1932
- <sup>4</sup> Brutt, H. Significance of Anaerobic Streptococci in Appendicitis. *Beitr z klin Chir*, 129, 175-185, 1923
- <sup>5</sup> Bower, J. O. Acute Appendicitis in Philadelphia, Report of Progress Made in Campaign for Its Reduction. *J A M A*, 102, 813-816, March 17, 1934
- <sup>6</sup> Coller, F. A., and Potter, E. B. The Treatment of Peritonitis Associated with Appendicitis. *J A M A*, 103, 1753-1758, December 8, 1934
- <sup>7</sup> Colwick, J. T. Reducing Mortality Rate in Cases of Perforated Appendices. *J Oklahoma M A*, 28, 374-378, October, 1935
- <sup>8</sup> Egdahl, A. Some Etiological Factors of Acute Appendicitis. *Mil Surg*, 73, 61-69, August, 1933
- <sup>9</sup> Dauer, C. C., and Lilly, G. D. Appendicitis Mortality Rates, Regional Differences in the United States. *Am J Surg*, 30, 119-124, October, 1935
- <sup>10</sup> Eliason, E. L., and Johnson, J. Diagnosis of Atypical Acute Appendicitis. *M Clin North America*, 19, 185-194, July, 1935
- <sup>11</sup> Findlay, F. M. Atropine as a Diagnostic Aid in Appendicitis. *New England J Med*, 208, 630-632, March 23, 1933
- <sup>12</sup> Finney, J. M. T., Sr. Analysis of Complications and Deaths Occurring in Appendicitis. *Am J Surg*, 20, 772-779, June, 1933
- <sup>13</sup> Garlock, J. H. Acute Appendicitis, Controllable Mortality Factors. *Am J Surg*, 23, 248-254, February, 1934
- <sup>14</sup> Gins, H. A. Bakteriologische Beziehungen zwischen Appendix und Mundhöhle. *Deutsche med Wchnschr*, 60, 1463-1465, September 28, 1934
- <sup>15</sup> Guerry, L. Mortality in Appendicitis. *ANNALS OF SURGERY*, 84, 283-287, August, 1926
- <sup>16</sup> Haggard, W. D. Appendicitis, Analysis of 3,344 Cases with Remarks on Delayed Operation in Delayed Appendicitis. *Am J Surg*, 28, 71-77, April, 1935
- <sup>17</sup> Hilton, D. C. Appendicitis. *Intern Clin*, 4, 244-264, December, 1932
- <sup>18</sup> Hobler, L. L. Appendicitis, An Analysis of 4,833 Cases. *ANNALS OF SURGERY*, 103, 86-96, January, 1936
- <sup>19</sup> Kehl, Geo. W., and Rentschler, C. B. Acute Appendicitis Complicated by Peritonitis. *Am J Surg*, 29, 373-378, September, 1935
- <sup>20</sup> Ludington, N. A. Etiology of Traumatic Appendicitis with Certain Clinical Observations. *J A M A*, 80, 1448-1451, May 19, 1923

- <sup>1</sup> McClure, R D Appendicitis Chronic ANNALS OF SURGERY, 94, 203-212, August, 1931
- <sup>2</sup> McGrath, J I, and Eiss, S Prevention of Late Post-Operative Complications in Acute Suppurative Appendicitis Am J Surg, 27, 112-120, January, 1935
- <sup>3</sup> McMullin, J J Differential Diagnosis Between Acute Appendicitis and Influenzal Myalgia Am J Surg, 19, 296, February, 1933
- <sup>4</sup> Newman, S H A Review of 268 Appendectomies Southwestern Med, 19, 41-52, February, 1935
- <sup>5</sup> Nuttall, H C W Immediate Operation for Acute Appendicitis Brit M J, 2, 1045-1046, November 30 1935
- <sup>6</sup> Priestly, J T Further Observations on Serum Therapy in Treatment of Peritonitis Secondary to Appendicitis Proc Staff Meet, Mayo Clinic, 11, 213-214, April 1, 1936
- <sup>7</sup> Quain, E P, and Waldschmidt, R H Acute Appendicitis, with a Report of One Thousand Consecutive Cases Arch Surg 16, 868-878, April, 1928
- <sup>8</sup> Reid, M R Some Remarks on the Operative Procedures for Appendicitis Surg, Gynec & Obstet, 59, 529-532, September, 1934
- <sup>9</sup> Reid, M R, Poer, D H, and Merrell, P Statistical Study of 2921 Cases of Appendicitis JAMA, 106, 665-669, February 29 1936
- <sup>10</sup> Schottmuller, H, and Biegold, W Die Septischen Erkrankungen in Mohr Stoeckhus Handbuch d inn Med, Bd 1, 1925
- <sup>11</sup> Smith, F M, and Miller, G H The Reflex Influence of the Colon Appendix and Gall Bladder on the Stomach Arch Int Med, 46, 988-993, December, 1930
- <sup>12</sup> Smith, T F H Trauma and Appendicitis Brit M J, 1, 283 February 17, 1923
- <sup>13</sup> Stanton, E M Acute Appendicitis, Study of Correlation Between the Time of Operation, Pathology and Mortality Surg, Gynec & Obstet, 59, 738-744, November, 1934
- <sup>14</sup> Taylor, C J G Trauma and Appendicitis Brit Med J, 1, 17, January 6, 1923
- <sup>15</sup> Van Zwalenberg, C Hydraulic Vicious Circle as It Develops in Acute Appendicitis Am J Surg, 16, 427-440, June, 1932
- <sup>16</sup> Walker, I J Why Increasing Mortality in Appendicitis? Am J Surg, 25, 228-242 August, 1934
- <sup>17</sup> Priestley, J T Generalized Peritonitis Secondary to Rupture of the Appendix Surg, Gynec & Obstet, 63, 675-680, November, 1936

## THE APPENDIX PROBLEM

A PERENNIAL CAUSE OF PREVENTABLE MORTALITY

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THIS year (1936) is the semicentennial of the epoch making paper presented by Reginald Fitz, in 1886, in which he reported the autopsy findings in 151 patients who died with abdominal pathology which originated in the vermiform appendix. It is also approximately the semicentennial of the first successful, preoperatively diagnosed, operation for appendicitis by Thomas G. Morton, in 1887, and in the same year a similar case by Sands. Many other investigators, even before the Christian Era and up to the present time, have made invaluable contributions towards solving the appendix problem. We who have inherited their achievements should be stimulated by their example to continuous efforts in solving the problem as a cause of death.

*Mortality Statistics*—During May, June, July, August, and September, 1936, there was a mild epidemic of poliomyelitis in Alabama and in some other states, during which 339 cases occurred in Alabama, 26 of whom died. As soon as an unusual number of cases were reported to the Alabama State Health Department, active steps were taken by the department to prevent the spread of the infection. The city and county health authorities and the Department of Health of the United States Government cooperated in every way in caring for those who were afflicted with the disease and in preventing its further spread. The press, civic clubs, churches, schools, and all other organizations, and the people generally, cooperated with the health authorities in preventing the occurrence of the disease. Those least informed in Alabama could not have been ignorant of the fact that there was an epidemic of poliomyelitis in the state and elsewhere. It occurred to the writer that if, in a degree, such cooperation could be secured in stamping out or preventing all preventable diseases and possible preventable deaths, such cooperative effort would be the cause of the saving of thousands of lives that are lost annually. Information secured from the Department of Public Health of Alabama gave the following mortality for appendicitis for the same months in 1935 as those during which the poliomyelitis epidemic had occurred in 1936: May, 24; June, 21; July, 32; August, 30; and September, 26 deaths, a total of 133 appendicitis deaths for the five months in 1935 or 26.6 per month. The Bureau of Vital Statistics of Alabama stated that the deaths due to appendicitis for the same months in 1936 "probably would not differ materially from that in the preceding year." The writer was amazed to find that so large a number die monthly in Alabama from the complications of the neglected appendix cases. It occurred to him, in the language of Doctor

Finney, Si, "that something should be done about it," namely, these perennial deaths which are due to appendicitis

According to the Statistical Bulletin of the Metropolitan Life Insurance Company for November 12, 1936, the death rate from appendicitis was 11.4 per cent per 100,000 for 1935, or 1.7 per cent lower than for 1934. However, the Bureau of Census of the U. S. Department of Commerce gives a mortality of 14.3 per cent per 100,000 population for 1934. It is interesting to note that the mortality per 100,000 population due to appendicitis from 1900 to 1934 has never been higher than 15.3 per cent per 100,000 population. In 1900 it was 9.7 per cent and rose gradually with recessions and fluctuations each year until the highest, 15.3 per cent, was reached in 1928. It was from 1925 until 1932 that it varied from 15 to 15.3 per cent (1931). For the years 1932, 1933, 1934, it was respectively 14.2, 14.1, and 14.3 per cent. There were 18,129 deaths in the United States in 1934 due to appendicitis. The mortality due to this condition in Chicago, Detroit, Los Angeles, New York City and Philadelphia averaged 13.7 per cent per 100,000 for 1934, whereas for 1935 it was 12.4 per cent, a reduction of 1.3 per cent, with Philadelphia having the lowest, *i. e.*, 10.9 per cent. The death rate of 60 selected cities in the United States for the year 1934 was 15.3 per cent per 100,000, whereas for 1935 it was 13.6 per cent per 100,000, a difference of 1.7 per cent. So, according to the statistics of the Metropolitan Life Insurance Company and the official reports of the Bureau of Census of the United States Government, the mortality due to appendicitis is being markedly reduced.

Appendicitis is not the only possible preventable cause of mortality. Table I, according to the Bureau of Census of the U. S. Department of Commerce, shows the statistical records of some such diseases for 1934.

The appendix is by nature a deficient, ill constructed test tube or cesspool of the intestinal tract. Anatomically, physically, and physiologically, it is a potentially obstructed tube with a terminal blood supply, the ingress and egress of its contents opposing each other. In the small lumen of the tube the opposing currents produce sedimentation and lamination which result in fecoliths in 59 per cent of the appendices as found in autopsies by Fitz. Intraluminal pressure produces intramural pressure and possible strangulation and consequent gangrene followed by rupture. There may be infection in cases where there is injury to the mucosa. There may be a hematogenous infection. Adolph Volz, in 1846, called attention to appendiceal concretions and their relation to perforations of the appendix. Von Zwalenbug, in 1904, and Wilkie, in 1914, reiterated faith in the belief that obstruction was a factor of major consequence for the occurrence of appendicitis. Wangenstein has recently emphasized the defective mechanism of the vermiform appendix—a potentially closed loop—and has designated it by nature as the sword of Damocles which always holds out a threat to the individual who has not had the appendix removed. According to Royster, at least three cases of prenatal appendicitis have been recorded. Cases also occur in the



extremes of life—in infancy and the very old. The appendix problem exists before birth and persists throughout life, unless or until it is removed. It is a little potential assassin (Royster) that may suddenly cause the most serious abdominal pathology and destroy the life of the individual. It is truly the sword of Damocles as far as the individual is concerned.

TABLE I  
STATISTICAL RECORDS OF DEATHS FROM SOME DISEASES  
OTHER THAN APPENDICITIS DURING 1934

Cause of Death	Number of Deaths	Rate per 100,000 Estimated Population
(1) Infectious and parasitic diseases	148,124	117.2
(2) Cancers and other tumors	140,771	111.3
(a) Of the digestive tract and peritoneum	65,476	51.8
(3) Rheumatic diseases, nutritional diseases, diseases of the endocrine glands, and other general diseases	42,568	33.7
(4) Disease of the blood and blood-making organs	10,250	8.1
(5) Chronic poisoning and intoxications	3,921	3.1
(6) Diseases of the nervous system and of the organs of special sense	134,365	106.3
(7) Diseases of the circulatory system	333,296	263.6
(8) Disease of the respiratory system	114,879	90.9
(a) Bronchopneumonia (including capillary bronchitis)	41,923	33.2
(b) Lobar pneumonia	54,794	43.3
(9) Diseases of the digestive system	95,961	75.9
(a) Diarrhea and enteritis (under 2 years of age)	17,019	13.5
(b) Diarrhea and enteritis (2 years and over)	6,192	4.9
(10) Diseases of the genito-urinary system	125,171	99.0
(11) Diseases of pregnancy, childbirth, and the puerperal state	12,859	10.2
(12) Diseases of the skin and cellular tissue	2,144	1.7
(13) Violent and accidental deaths	132,022	104.4
(a) Suicide	18,828	14.9
(b) Homicide	12,055	9.5
(c) Accidental, other, or undefined	101,139	80.0
(1) By fall	20,762	16.4
(14) Automobile accidents (primary)	33,980	26.9

*Appendicitis, A Neglected Medical Educational Problem*—In an outstanding recent book (1936) on the practice of medicine by a great medical man, appendicitis does not appear in the index of diseases in the text. Recently, in discussing the advances in gastro-enterology, an outstanding and learned member of this specialty left the appendix out of consideration entirely. Said he: "I shall actively oppose narrow specialism in any branch of medicine, there can be no doubt that such an unfortunate state has arisen and continues to exist, to the inevitable detriment not only to specialism but also to medicine as a whole. I prefer to be considered a properly trained internist who is devoting himself especially to diseases of the abdomen having

both direct and indirect relationship with the digestive organs. The men working in the domain of diseases of the digestive tract are not confining their efforts to a restricted field but are continually reaching out to explore all the areas that may conceivably influence that realm. They are constantly evolving new and useful ideas as to etiology, pathology, symptomatology, diagnosis and therapy in every ramification of the digestive system, every factor bearing on the digestive tract has been considered, every phase of its manifold functions has been studied, and this great volume of effort furnishes us with not only many stimulating problems but also with clues for their final solution. All signs, indeed, point to ever higher pinnacles of achievement. The fellow human beings who place their health, and thus their lives, in our hands, have the right to expect from us all the security that our high standards can provide." Pendergrass, in a paper on "The Small Intestine," omitted the appendix from consideration.

The appendix is evidently considered an entity, and the fact that it is a part of the intestinal tract and is so frequently the entire cause of serious disturbances in the entire digestive system and is the cause of so many preventable deaths seems not to be considered by many members of the profession whose active and helpful cooperation must be had in preventing deaths due to appendicitis.

*Education, Experience and Ability of the Surgeon in Relation to Mortality*—Battle, in 1932, called attention to the large number of cases of appendicitis admitted to the hospitals of London. He said from the year 1873 to 1893, from one to 28 cases with inflammatory masses in the iliac fossa, with rarely more than 13 cases for any one year, were admitted to St. Thomas Hospital. All were turned over to the Medical Service. They rarely required operation and then only a simple incision and drainage. From 1869 to 1892, from one to 13 cases of peritonitis were admitted annually. "There was a change in 1893," said he, "in the character of the disease." In 1895, there were 59 cases admitted. This number increased each year until in 1913 there were 571 cases. The total admissions to St. Thomas from 1894 to 1930, excluding the war years, was 9,481. "The figures can only be comparatively correct," said Battle, "for in more recent years a new section of abdominal pain has appeared." I have summarized his report because to my mind it represents an epoch in medical education at least as to the recognition of abdominal pathology due to the neglected appendix or possibly in some cases a recognition of early cases of acute appendicitis.

The change in 1893 in the character of the disease—appendicitis—as noted by Battle, which was doubtless not a change in the disease but a change in the educational status of the men who handled the cases, was also noted before this time in America. Following the appendicectomies by Morton and Sands in 1887, American surgeons recognized immediately that a change in the recognition and treatment of the disease was necessary. Many made early and valuable contributions on the subject of appendicitis and its complications. In 1890, the subject of the treatment of general, septic peritonitis

was discussed at a meeting of the Southern Surgical Association. In discussing this paper, Dr W E B Davis said, "These cases are before us constantly. The physician should be educated up to the point to recognize this condition so that he may call a surgeon at a time when he can do some good and not after it is too late. We are losing patients by delaying operation and simply because the general practitioner does not appreciate the importance of the disease. We are rarely ever called until three days after rupture has taken place. Before this time, all manner of treatment has been resorted to and we are now called in and expected to operate. I have suggested an operation which I believe, is practicable in cases of suppurative peritonitis with great tympanites and obstructive symptoms and it is this. Open the abdomen, incise the intestine, wash out with hot water and make an artificial anus. This will relieve the tympanites and give the patient the best chance to recover." Dr J D S Davis said "In those cases of appendicitis where there is a formation of pus, the abscess should be opened. We do a life-saving operation. We should not subject the patient to too great a shock in removing the appendix but after the patient recovers from the appendiceal abscess, we can then remove the appendix." That was and is modern surgery as we know it today. The question of purges or salines in cases of appendicitis or its complications up to 1893 and even later, was one that caused considerable discussion among surgeons and medical men. Dr Joseph Price said, in 1893, "It is curious how medical men differ from us. I heard Professor Hare say that under no circumstances would he give salines in cases of appendicitis; that surgery should precede the saline treatment." Dr Hunter McGuire, in 1893, said, "Not more than a year ago in discussing the subject of appendicitis, I said, 'there was no subject in surgery about which I was more uncertain than when to wait or when to operate in these cases.' I confess," said he, "in these cases, I have never operated too soon but have many times operated too late." Doctor Tisfany of Baltimore said, "The majority of cases of appendicitis we do not see at all. An early diagnosis makes a clean operation, a clean belly cavity and the patient does well." Dr Bacon Saunders, in 1893, discussed an extraperitoneal method of operating in "Certain Cases of Appendicitis" and urged that all intra-abdominal abscesses be opened extraperitoneally.

Sir James Berry, in 1932, called attention to his letter to The Lancet in 1889 in which he reported 41 abdominal abscess cases opened by incision with only two deaths (extraperitoneal incision), and 39 cases treated by free incision into the general peritoneal cavity in which there were 32 deaths. He referred to the free incision into the general peritoneal cavity in which there were 32 deaths in 39 cases as an operation which was then beginning to become fashionable and which is now—1932—so common. "I do not claim," said he, "that the two classes of cases are in every respect strongly comparable but approximately they are representative of the two widely different methods of treating appendicitis by two sets of surgeons in the same hospital in the '90's, and also at the present time (1932)." "

He also, in 1932, referred to two historic cases as showing the manner in which similar cases were handled in 1902 and 1925 by different surgeons as indicating the difference in the methods of operative treatment

Case 1—King Edward VII Age 61 1902

Saturday, June 14	Abdominal discomfort
Sunday, June 15	5 A M Seen by doctor for acute attack of pain Afternoon Seen by consulting physician ? rigor
Wednesday, June 18	First seen by surgeon Temperature Pain and swelling in the right iliac fossa Diagnosis "peri-typhlitis" (i.e., appendicitis)
Thursday, June 19 } Friday, June 20 }	Above signs disappearing
Saturday, June 21	Seen again by surgeon Swelling nearly gone Temperature normal
Monday, June 23	Seen by surgeon
Tuesday, June 24	Operation Limited incision into intraperitoneal abscess Much foul pus drained Appendix not removed, not seen, not felt
Afterwards	No recurrence Lived nearly eight years

Case 2—President Ebert of Germany Age 54 1925

Sunday, February 22	Very well all day
Monday, February 23	In night slight abdominal pain 9 A M Seen by doctor 5 30 P M Severe abdominal pain Doctor sent for 6 P M Tenderness and slight rigidity in right iliac fossa 9 P M First seen by surgeon Immediate operation to be performed Moved to nursing home
Tuesday, February 24	12 Midnight Operation Free incision into peritoneal cavity Removal of appendix Turbid nonodorous fluid Intestines distended Pelvis quite free from fluid
Saturday, February 28	Death Postmortem examination

He said with reference to King Edward's case, "The incision was made low down until an abscess was reached and opened, tubes and gauze were inserted and nothing more done" "There is no little irony," said he, "in the fact that the popularity of the modern operation of treating appendicitis by free incision and removal of the appendix and abscess without regard to limiting adhesions is largely based upon ignorance of what was really done at this famous operation" In discussing the case of President Ebert, he said, "Twenty-three years have elapsed Surgical fashions have changed The septic focus—this dangerous appendix—must be removed at the earliest opportunity at any cost Surgical technic has greatly improved, it is true, but the disease called appendicitis remains what it has always been even when it was not known by that name As I read this report (the Ebert case) as given, I could not help feeling that I was back again in the good old days at St Bartholomew in the '90's when I, as surgical registrar, was myself seeing things then and recording them in the postmortem book and in my annual surgical reports"

It is not stated that a diagnosis in King Edward's case was made until the surgeon saw him on the fourth day after the initial attack The "swelling

in the right iliac fossa" had formed during the four days. The indicated surgery was correctly performed at the proper time. If the diagnosis in President Ebert's case could have been made early on the morning following the attack during the night, and the operation performed early or within a few hours, all can agree it would have given him a better chance for recovery. Surgeons have not and possibly never will be able preoperatively to determine the absolute state of pathology in or due to an infected appendix and the course the disease will pursue, but surgeons do know that the infected appendix is treacherous and deadly and the safe thing to do is to remove it unless an abscess is formed which can be opened extraperitoneally, or the patient is growing progressively better. It appears to the writer that neither case was a good surgical risk. They correspond in type with the two cases that died in the group of 2106 cases in Finney's series. Finney said, "These deaths were in men of middle age, of short, thick pudgy build, marked beforehand as relatively poor operative risks and both of whom were subjected to through abdominal exploration as well as the appendectomy through a right rectus incision. Both followed the same postoperative course, a paralytic ileus with progressive distention and total lack of peristalsis, dying after about a week with a terminal pneumonia. In each case, the absence of peritonitis was definitely proven."

Boland, in 1932, in a review of 4,272 cases of acute appendicitis in Atlanta, called attention to the large number of articles on the subject of appendicitis which had been published and which occur annually in medical and surgical journals. With irony he called the attention of the Section on Surgery, General and Abdominal of the American Medical Association to the fact that only five papers had been read in the Section in the past 15 years and that the last one was read five years prior to his paper in 1932. "The medical profession," said he, "must not let familiarity with the commonest of all surgical diseases induce criminal somnolence."

Haggard says the mortality of appendicitis decreases with the experience of the surgeon. Bowers called attention to the difference in mortality of surgeons. In the cases reviewed by him, one surgeon had a mortality of 20 per cent, another 33 per cent, while several had no mortality. In 2,806 cases of appendicitis reviewed and reported by Reid, 72 different surgeons operated, "the mortality of the individual surgeons varied greatly."

*Education of the Public as to Appendicitis*—The appendix problem has been, is, and should continue to be an educational problem. The solution of the problem depends upon certain very definite information which the people, individually and as a whole, must have relative to the symptoms and physical signs of appendicitis. It is the writer's conviction that the educational campaign for the purpose of giving this information to the people should be adequate, continuous, and orderly, and should be sponsored by the Health Department of the National Government, and of the states, counties, and cities, and that the instruction should extend to and be a part of the instruction of children in all grades of schools, so that the child, at least of

school age, can protect itself in case of an illness with abdominal symptoms due to appendicitis, or possible appendicitis, until he has been seen by a competent physician or surgeon

If every case of appendicitis could be diagnosed early and operated upon promptly, it would be of inestimable value socially and economically, and would relieve patients of untold suffering and agony and would reduce the mortality from this disease to an incredibly low figure. The children in the schools, the boys and girls and young men and women in colleges and universities, and the people generally, should be told the importance of the alimentary tract and something of its structure and function, and in this instruction the appendix should not be left out of consideration. But it should be especially emphasized that it is frequently the cause of a serious illness (appendicitis) which, if not recognized early and handled properly from the beginning, may result fatally. It should be generally known that the first symptom of appendicitis is epigastric pain or distress which is usually followed by nausea and vomiting and later pain on pressure in the lower right side, followed possibly by temperature, and that purges and opiates should not be given in such cases. Individuals and the people generally should know the importance of the timely advice of a good and properly prepared physician in such cases. It should be known by properly prepared physicians that purges and opiates in such cases must not be given until the appendix is absolutely eliminated as the cause of the illness. It should be known by all that an early diagnosis should be made and that an early operation is a safe surgical procedure followed by a very low mortality, less than one-half of one per cent, and yet if complications develop from the neglected attack, there may be a very high mortality rate.

McClure, Reed, Boland, Roberson, Poole and others have called attention to the fact that certain groups under proper control and regulation have a very low mortality due to appendicitis. In 300 cases of college students reported by Roberson, there was only one death, and in 219 cases of college students and nurses reported by Boland, there were no deaths. Horace Reed says, "In our own state efforts are being made to educate the public on the early signs of acute appendicitis. In one large organization in our state in which there are something like 4000 employees this information has been disseminated and over a period of nearly three years there has not been a death from acute appendicitis." Poole referred to the fact that patients are now admitted earlier to the Employees' Hospital of the Tennessee Coal, Iron & R. R. Co., Fairfield, because the industries of the company are more centrally located and the hospital is more accessible to the employees. It has been observed by McClure, with whom I agree, that nurses with appendicitis are promptly diagnosed and operated upon with practically no mortality.

Important methods are being used in certain cities and states to reduce the mortality due to appendicitis, and the efforts have met with considerable success, but not the success it would appear that should be expected. Notwithstanding this, great good has been accomplished and will be accom-

plished, and those who started the campaign in Philadelphia, and especially Doctor Bowers and his associates and the health authorities, cannot be commended too highly for the work which they have done. It is really outstanding. What they have done and what has been accomplished show how difficult it is to handle the appendicitis problem. It is a complex, compound problem. It is a problem that vitally concerns the people as a whole and every individual who still has his appendix within his abdomen. It is known that it is difficult to disseminate knowledge and difficult to get people and individuals to realize that they do not know all about a problem. Even after the people have the knowledge that they should have with reference to appendicitis, there will be even then a large number of insidious, deceptive cases that will slip up on, and take the life of, an individual or individuals under the guise of an illness with comparatively slight symptoms of the destructive pathology in the abdomen which threatens, and will destroy the life of, the individual unless the diagnosis is made and the appendix is removed. The most educated and informed citizens, and even physicians and surgeons, can be and many are attacked by this insidious disease, and the disease progresses to such a stage that serious complications develop even before the individual recognizes that he is seriously ill. The appendix is truly, as Royster says, an assassin.

*Diagnosis*—The insidious and deceptive nature of an attack of appendicitis with the variable symptoms and signs that may be present may cause the most learned and experienced physician or surgeon to miss a correct diagnosis. The attack may mimic in its symptoms, physical signs and laboratory findings, many diseases in the abdomen and remote therefrom, or there may be a most virulent infection of the appendix with practically no symptoms indicating its diseased condition. It may simulate many different diseases and many diseases may simulate it. There are some members of the profession who can paint the picture of the preoperative diagnosis of appendicitis so plainly as to cause one to see the appendix present itself before the incision is made, and after making the incision the appendix is found and removed with the greatest difficulty. The diagnosis may be comparatively easy. There are cases, however, that are most difficult and require thorough study. In such cases all means of diagnosis should be used. There should be no delay, but there should be a thorough study of the case which will enable one to make a correct diagnosis or at least to decide that the operation is or is not indicated. The patient should be so studied as not to permit the disease to become progressively worse from the appendix or any other possible intra-abdominal cause amenable to surgery. In this study there should be

First, a complete, accurate and correct history of the case and especially of the present illness. Second, a complete and thorough physical examination. Third, a total and differential blood count and complete examination of urine. Fourth, the usual symptoms and physical signs of appendicitis must be properly correlated and interpreted. Fifth, in certain cases even of the acute type a diagnosis can be confirmed or corrected by a cystoscopic

examination and roentgenologic findings Sixth, it is most important that pneumonia be eliminated as the cause of the abdominal symptoms

In a large series of cases, Livingston found hyperesthesia present in the appendiceal triangle in 86 per cent, leukocytosis in 76 per cent, pain in 75 per cent, nausea and vomiting in 70 per cent, temperature in 67 per cent, rigidity in 59 per cent Reid found in 1465 cases of acute appendicitis, the following clinical data Nausea 78 per cent, vomiting 73 per cent, abdominal pain 94 per cent, rectal tenderness 44 per cent, purgatives 36 per cent, and a typical history in 53 per cent Pain on pressure over the appendix was present in nearly 100 per cent He considers this the most important single symptom, and wisely says, 'When this tenderness is present, the burden of proof is certainly on the examiner to show that it is not due to appendicitis' Muscle spasm and rigidity were usually but not always present In some cases pain was elicited only on very deep pressure, in these cases the appendix was usually behind the cecum or in the pelvis Nausea and vomiting usually occurred in the first few hours of the disease, but in some cases it did not appear until late Tenderness, induration or a mass on rectal or pelvic examination was present in almost half of the cases "Rectal examination is of particular value in children in whom a diagnosis is frequently very difficult" Reid's cases were admitted late—unruptured cases averaged 44 hours

George Robertson published a most important paper on "Disturbed Reflexes, Their Significance in Acute Abdominal Diseases," and states that "absolute uniformity of symptoms in appendicitis is not found" He refers to Cope's division of the abdominal cavity into "the demonstrative area" and "the silent area" as being good "Cope defines the 'demonstrative area' as being the whole peritoneal lining of the abdominal cavity, minus the pelvis and central and inferior parts of the posterior abdominal wall which is designated as the 'silent area' In a large number of cases studied, Robertson found that rigidity in appendicitis does not occur unless the infected appendix is adherent to the 'demonstrative area,' or adherent to the omentum or intestine or a viscus which is involved in the infection and is itself adherent to the parietal abdominal wall, or the appendix is ruptured and the parietal wall is contaminated by its contents" From my own cases and the observation of a large number of others, I agree with Robertson that if rigidity occurs in appendicitis, it indicates an involvement of the peritoneum in the infectious process Rigidity may be an early or a very late finding The diagnosis, if possible, should not be delayed until the infectious process has involved the parietal peritoneum, thus producing rigidity Robertson designates rigidity as a "sensory motor reflex" He states that "strong sympathetic stimuli from a diseased viscus are not responded by the contraction of a voluntary muscle They are responded by a strong and continued reflex contraction of the plain muscles of the gut This is the true visceromotor reflex It is not an objective sign but is a subjective symptom, and is expressed by the patient as pain of a certain character and frequently located far away



from the diseased viscus. The epigastric pain of acute appendicitis is due to a spasmodic contraction of the pyloric sphincter, and is described by the patient as epigastric. The periumbilical pain of acute appendicitis is due to strong peristaltic contraction of the lower ileum against a contracted ileocecal sphincter and is described by the patient as periumbilical. This reflexed disturbance is visceral and is of the autonomic nervous system. Visceral abdominal pain is due to vigorous peristalsis of involuntary muscle or contraction of sphincteric areas often at a distance from the point of stimulation. Rigidity on the other hand may be general or local, depending upon the extent of involvement of the parietal peritoneum. It is a sensorimotor reflex."

Murphy said that the primary pain with a free appendix is always referred to the epigastrium. The secondary pain is usually not colicky, but of the typical inflammatory type and is due to periappendicitis. Rutherford Morrison said, "There would be no percentage of deaths from appendicitis if every case commencing with acute pain and developing tenderness and rigidity of the abdomen and quickening of the pulse were operated upon within 12 hours." This statement with reference to pain and rigidity, as well as McBurney's point of greatest pain, is misleading. They are frequently quoted in the literature on appendicitis, but the use of the word "pain" is not explicit. To wait for subjective pain at McBurney's point is to court disaster. It must be recognized that in most cases, the primary or initial pain is epigastric, umbilical or a generalized abdominal pain. There is usually tenderness on pressure at McBurney's point or at the point where the appendix is in the beginning, but the subjective pain and objective rigidity at this point may be and most often are late developments and indicate complications.

*Chronic Appendicitis*—Those who are interested in chronic appendicitis would do well to read carefully McClure's paper which was presented to this Association in 1930. Foy Roberson in 1934, also strikingly called attention to what he regards as being chronic appendicitis. Royster has studied the subject most thoroughly and in discussing Roberson's paper said, "Let me illustrate what he (Roberson) said about the disease. Why should we use the terms 'chronic' or 'acute'? The attack is not the disease, only a knock at the door saying 'Let me out.' The chronic type is sometimes difficult to diagnose but I stand pat on the idea that the fulminant case is only the accumulation of years of pathology."

Haggard says chronic appendicitis is so easy to say and yet means so little. "We have little reason for diagnosing chronic appendicitis in the absence of definite acute or subacute attacks." There were in his large series of operative cases only 113 chronic cases. The writer has operated upon only one patient with a diagnosis of chronic appendicitis, but he has operated upon patients with the symptoms and signs of acute appendicitis which the pathologist reported as chronic appendicitis. He believes, however, that there are many cases of chronic appendicitis which should be operated upon, but in his experience he has not been able in his own mind to insist upon an

operation in such cases This does not alter his conviction, however, that chronic appendicitis is widely prevalent and that many chronic cases become fulminant, acute cases

### ILLUSTRATIVE CASE REPORTS

**Case 1**—In 1912 a doctor was operated upon by Doctors Davis and Talley He had had for a number of years pain on pressure over McBurney's point, and for the last year or two before the operation, occasionally late at night, he would vomit what he had eaten at lunch and at dinner There was no epigastric pain, no tenderness, no acceleration of the pulse The only symptom present was pain on deep pressure at McBurney's point and vomiting He knew, or believed firmly, that he had a chronic appendix and he expected to be operated upon at a convenient season before he had an acute attack He does not remember ever having had a previous acute attack of appendicitis The acute attack which occasioned the operation began at 1 A M after he had attended an elaborate dinner the night before He vomited two or three times during the night, got up early and operated on several cases before lunch At lunch he took broth and immediately became very nauseated He left the table and went to bed He was very sick with nausea and exhaustion during the entire afternoon and night He took no medicine At 10 P M he decided that he had an acute appendix, and he was operated upon the next morning at 10 o'clock He knew that he should have been operated upon as soon as a diagnosis was made but he did not want to trouble anyone at night, the diagnosis was made late Up to that time he thought it was an indiscretion in diet At operation a right rectus incision was made and a very large, gangrenous appendix presented itself It was removed and a very small drain was placed just within the peritoneum in the lower angle of the incision There was an uneventful recovery This doctor believes firmly that if he had not been operated upon at the time he was for the acute attack of chronic appendicitis, he would have died

**Case 2**—Another instance was that of a doctor whom I saw in an acute attack of appendicitis in 1926 Since it was a mild attack he insisted that he could not take the time to be operated upon unless it was absolutely necessary He improved steadily and within two or three days resumed his duties In 1928 his wife called me late one night and asked me to come at once as her husband was very ill, and before I could get dressed she called again and said she was afraid he would die before I could get there When I saw him he was in the greatest agony, vomiting, bowels moving, cold perspiration, slow pulse, generalized abdominal pain, which was most acute in the upper right quadrant Since his mild attack of acute appendicitis in 1926, he had been troubled with gastric distress for which he took bicarbonate of soda I had told him at different times since his acute attack that he had chronic appendicitis following the acute attack, which was the cause of all of his trouble He believed it was due to his gallbladder When I saw him in his latest acute attack, I believed firmly that all of his trouble was due to his appendix I knew he would be operated upon and I gave him half a grain of morphine immediately and within 30 minutes another quarter of a grain, after which he was more or less relieved of his severe pain I wanted him to go to the hospital that night but he delayed until early the next morning Doctor Talley and I operated about 10 A M the following morning He had a large, gangrenous, obstructed unruptured appendix The incision was closed without drainage and he made an uneventful recovery, but about a year later he had a large intramural abdominal abscess just above the old appendix scar

The writer now has in his files 86 cases which he believes have chronic appendices Some of them have subacute attacks periodically He has warned all of them that they may have a fulminating attack at any time

**Case 3**—A patient on whom I operated was of considerable interest to me. A young woman, a school teacher, age 24, had been thoroughly examined by members of the staffs in two high class hospitals with no diagnosis of any abdominal pathology. She had for the past two years been suffering with indigestion (dyspepsia) and pain in the right lower quadrant and just above the symphysis, metrorrhagia and menorrhagia. The G. I. series and examination of the urinary tract were negative. She had been on a diet for several months. As she had been treated for the menstrual trouble over a long period of time by good men, I decided to perform a diagnostic curettage. Macroscopically there was no evidence of pathology in the uterine scrapings. Because of the indefinite pain in the right lower quadrant and just over the symphysis, although the pelvic examination was negative, I decided while the patient was under the anesthetic, to perform a laparotomy for the purpose of removing what I regarded as being a chronic appendix. A midline incision was made between the symphysis and the umbilicus. On examining the uterus, a rough surface was found on the posterior of the right cornu. Running from the omentum in the pelvis, there was a very sharp, fibrous cord, about 12 cm. in length, extending to the tip of the appendix. The appendix was long and there were several kinks in it. The appendectomy was performed. There was an uneventful convalescence, and there have been no abdominal or menstrual symptoms since. There were definite indications for the above operation, and the result has been extremely gratifying to the young woman, her family and friends.

*Preoperative Preparation*—It is recognized that in the absence of the very greatest emergency that every patient can be properly prepared for an operation. This may require the giving of glucose and normal salt solution intravenously, normal salt solution by hypodermoclysis or the transfusion of blood and such anodynes and other medication as may be indicated. The preoperative treatment may be instituted and carried out during a thorough study of the patient, during which time the patient may be gotten into the very best possible condition to undergo the operation. The operation can be performed when indicated but it should certainly not be performed until the patient has such preparation as will enable him or her to be in the best possible condition to undergo the operation, and if, under such treatment, the patient becomes progressively better, the treatment may be continued until it is indicated that the operation should or should not be performed.

*Operative Procedure*—Desirable as it is to avoid controversial questions or problems, yet in matters that are fundamental, one who avoids such issues cannot be intellectually honest. The question of immediate operation after the indicated preparation of the patient or delayed and possibly nonoperative treatment of the patient with local, diffuse, spreading, or general peritonitis is one that such surgeons as Richardson, Ochsner, Murphy, the Mayos, Price, McMurtrey, Haggard, Sr., Shellen, the Davises, and many other pioneer surgeons considered most seriously. The same question or problem is now uppermost in the minds of surgeons who are striving to render the greatest possible service to their patients. It is only second in importance to an early diagnosis and early operation in which the mortality is practically nil. Almost perfect results are reported by some surgeons who practice either the immediate or delayed procedure in the indicated case. The surgeons who get such a low mortality by either procedure evidently have adapted the procedure

to the patient rather than the patient to any fixed plan of preparation and operation. The patient with an abdominal complication of appendiceal origin is individualized, studied, treated and operated upon immediately when indicated, or is not operated upon when not indicated. Each experienced surgeon uses the preoperative, operative and postoperative procedures indicated in the individual case that will give, according to his knowledge and experience, the patient the best chance to recover. The surgeon owes it to the patient to use at least the known and approved methods of preoperative, operative, and postoperative treatment, which when used by the ablest surgeons give good results.

The expression by Richardson that "there are instances in which we see the case too late for the early operation and too early for a safe late operation" frequently occurs in the literature. To understand what the author meant by such an expression, it would seem that it is only right and proper to consider the entire context from which the quotation is abstracted in order to understand the real meaning which the author wished to convey. For this reason, I am quoting the entire paragraph from Richardson's original paper, in 1894, in which the expression "it seems to me—though I am by no means convinced of the truth of this assertion—that there are instances in which we see the case too late for the early operation, and too early for a safe late operation" originally occurs.

Richardson said, "I have often seen a patient for the first time in the third, fourth, or fifth day of an attack of severe type in which Nature had succeeded in opposing an adhesive barrier to further extravasation. Under these conditions the most important and difficult question arises—whether to operate or not. I have considered this question many times. It is during these days—the third, fourth, and fifth, or later—that the early operation may be said in some cases to be too late. The extravasation from the perforated appendix has taken place, the harm from this extravasation has been done, Nature, in her own way, has successfully, thus far, opposed this extravasation. The adhesions are not strong, and in separating them we are almost sure to contaminate the rest of the peritoneal cavity. It seems to me—though I am by no means convinced of the truth of this assertion—that there are instances in which we see the case too late for the early operation, and too early for a safe late operation, that if we operate we undo the work that has thus far been successfully accomplished by Nature, and that we convert a case that is doing well into a case of fatal general peritonitis. This is one of the most important questions in connection with the discussion of this disease. I do not mean to assert that interference in a localized peritonitis on the third, fourth, or fifth day is inadvisable. I have operated many times at this period. I have done this, however, with the greatest care not to break down the recent adhesions. There is no more difficult operation in surgery than that of removing an appendix at this stage without infecting the general peritoneal cavity. I do not mean to assert that, on the third, fourth, or fifth day, in a case that is getting on well, with a localized abscess, we should delay, but

the reasons I have given must appeal to one who dreads the presence of infecting material in the peritoneal cavity. The objection to leaving to itself a case in which presumably the adhesions are not strong is the giving way of these barriers under pressure and consequent fatal extravasation. That this danger is by no means slight is seen in the constant occurrence of a general peritonitis in cases that are apparently doing well. Where the symptoms of general peritoneal infection appear suddenly, in the course of a localized peritonitis several hours at least must elapse before the surgeon can attempt to repair the mischief. Where the adhesions are broken down by the operation these efforts to cleanse the peritoneal cavity can, of course, be made at once."

The conservative treatment of appendiceal peritonitis as advocated by A. J. Ochsner, and later by Sherman, and the application of Richardson's principles of operative treatment, were recently very lucidly discussed in a paper by Alton Ochsner. This paper gives valuable information relative to the deferred operation in the indicated case.

*Abscesses*—It is very clear that Doctor Richardson believed that in cases seen late—on the third, fourth, fifth or sixth day and later—where an abscess was being formed, and the patient was doing well, there should be no interference—no operation until the abscess was firmly walled off and could be opened extraperitoneally without reinfected the patient. This position relative to opening abscesses, so as not to contaminate the abdominal cavity, was taken by Robert James Graves, about 1840. "One of his original ideas was a mode of treating hepatic abscesses so as to insure the patient against the risks consequent on the escape of purulent matter into the cavity of the peritoneum. The case cited by Graves was that of an hepatic abscess. The surgeons who saw the patient felt that the signs were too diffuse and the situation of the abscess uncertain, so that the operation not only afforded little chance of success but might prove very detrimental. They accordingly refused to operate. It occurred to Graves that if an incision were made within one or two lines of the peritoneum and kept open with a packing, the abscess might tend toward and finally rupture through it. One of the surgeons, Mr. MacNamara, finally consented to perform the operation as described. The result was awaited by Graves with much anxiety, two days later, the patient sneezed and a large quantity of pus escaped, followed by rapid recovery of the patient. Graves and others used this method on additional cases with much success." The earlier operators were so impressed with the importance of avoiding a recontamination or reinfection of the peritoneal cavity that many of them advised a midabdominal incision in order to locate the abscess before attempting to drain it extraperitoneally. Of course, this was an extra hazard to the patient and in time this plan was abandoned, and it became almost universally recognized, as it is now, that abdominal abscesses should be opened extraperitoneally. The abscess should be opened, if possible, where it points, at the place of greatest pain or tenderness or fluctuation. Herrick and McDill, in operating upon liver abscesses,

emphasized the importance of avoiding contamination not only of the pleural cavity but also of the abdominal cavity. Elkins has emphasized this in operating for subdiaphragmatic abscesses. The Herrick and McDill operation of resecting a rib (the tenth), pushing up the pleura, incising the diaphragm and attaching the diaphragm to the intercostal muscles and opening the abscess, only if it was walled off from the peritoneal cavity, and in case it was not, packing the abscess area in the liver with gauze and opening it within 24 to 48 hours, avoids contamination of the pleura and abdominal cavity and gives a remarkably low mortality record in operating on abscesses of the liver. It is found in practical experience by good surgeons that most intra-abdominal abscesses can be opened without reinfecting the abdominal cavity. Where the abscess is inaccessible and must be opened intra-abdominally, it appears that it would be ideal to have the intra-abdominal drain so placed that the drainage tract would be walled off as in liver abscesses before the abscess is opened or ruptures spontaneously. It seems to be agreed that those patients who are seen early after an appendiceal rupture or intra-abdominal rupture of an appendiceal abscess should be operated on without delay. In the case, however, seen late, where there is no evidence of abscess formation and there has been ample time for Nature to have formed an abscess and the patient is desperately ill, the question is whether or not this patient should be operated upon immediately after proper preparation or should be delayed as to operative treatment until an abscess is formed. In such a patient, which method gives the better chance of recovery? Extreme positions have been taken with reference to this type of patient. There are those who believe that immediate operation should be performed. There are others who think that such a patient should be put upon treatment—Fowler-Ochsner-Murphy treatment—and that the operation should be performed only after the patient is in condition to withstand the operation or be operated upon successfully. All surgeons, I am sure, would adopt the latter procedure if they could know that such a procedure would be in the interest of the patient. Richardson, as I interpret what he said, used the latter method of treatment in those cases seen late that were improving.

In 1921, the writer in presenting a paper to this Association on "Conservative Surgery in Non-Malignant Diseases of the Pelvic Organs" stated that extreme positions have been taken and that there are doubtless good reasons for the extremes. While this is true, good judgment will always dictate the solid foundation or principle on which those who hold to either extreme may compromise in the interest of the general good—in this case, the patients. Ultra-radicalism and ultra-conservatism may be equally disastrous—the one precipitately, the other slowly but surely. He believes the same may be said with reference to the appendix.

*Mortality as Reported by Surgeons*—In an editorial in the American Medical Journal, June 20, 1936, on "Reducing the Mortality of Acute Appendicitis," reference is made to the record of Dr. LaGrand Guerry's report of a mortality rate of 14 per cent in a group of 135 cases of gan-

genuous ruptured appendicitis with diffuse peritonitis treated by the Ochsner method, and also to 502 consecutive cases of acute appendicitis reported by Guy W. Horsley, Jr., in which an immediate operation was performed with a mortality rate of 0.8 per cent, with the remark wisely that "there can be no doubt that the skill and judgment of the surgeon play an important part in the mortality rate of any operative procedure." H. A. Gamble, has recently reported 129 operated cases of peritonitis due to appendicitis with two deaths, a mortality of 1.55 per cent.

Bowers has shown that the reduction in mortality due to appendicitis is a most difficult task. In his review and thorough analysis of 8,216 cases in the hospitals of Philadelphia after an intensive educational campaign, it is shown that there was a reduction of 1.16 per cent mortality in 3,095 cases for 1930 as compared with the mortality in 5,121 cases for 1928 and 1929, the mortality for the two series being respectively 4.81 and 5.97 per cent. The decrease in the time (11.81 hours) of admission in the 1930 series and its relation to decrease in perforations—from 42.73 to 35.45 per cent—together with the relation of purgatives to spreading peritonitis, show clearly the way to prevent mortality due to appendicitis. J. M. T. Finney, Jr., in a study of 3,913 cases, and many other surgeons who have studied and reported large series of cases have shown that the mortality in simple uncomplicated appendicitis is very low—less than 1 per cent. Alton Ochsner, McClure, Gile and Bowler, Collier and Potter, Garlock, Boland, Maes, Reid, Keyes, Haggard, Roberson, and many others in this and other countries have recently presented notable papers on appendicitis reviewing large series of cases. Each one has emphasized the type of case in which mortality occurs, and the way to prevent or reduce the mortality. In studying their papers, it is not always clear that surgeons understand each other in discussing the different complications of appendicitis, and there is a great difference in mortality in certain types of cases as given by different surgeons, but the average mortality of the whole series of each good surgeon when compared with that of other good surgeons does not differ markedly. All surgeons agree that the cases of appendicitis in which the infection extends beyond the appendix are the ones in which mortality occurs and it is those cases that cause so much trouble and discussion. The study and discussion of appendicitis has caused a marked reduction for the past three years in the mortality due to appendicitis and its complications. DeCoucy, in 1936, in reporting 757 cases of all types operated upon during 1935, gave a reduction in mortality of 1.1 per cent from that of 1931, and for the perforated group a reduction of 5.7 per cent. "Walker found a mortality of 7.8 per cent in a review of more than 16,000 cases of appendicitis collected from the literature during the years 1907 to 1910, and a mortality of 5.3 per cent in 33,000 cases from 1927 to 1930." In Finney's series of 3,913 the mortality was 2.33 per cent. Garlock, in reporting 443 cases of acute appendicitis with a mortality of 4.6 per cent, called attention to the fact that in an earlier series of 755 cases the mortality was 6.2 per cent, a reduction of 1.6 per cent in



the later series. The cases of the two series were practically of the same type. He attributed the reduction in mortality to more carefully supervised and actively extended postoperative care of the sick cases. The average mortality in the 2,921 cases reviewed and reported by Reid was 9.53 per cent for the years 1915 to 1921 inclusive and 6.3 per cent for 1922 to 1933 inclusive. The average mortality for the last 12 years was 5.4 per cent. Pool, in reviewing 757 cases operated upon at the Employees' Hospital from November, 1919, to September 1, 1935, said 500 cases of the series were operated upon up to 1930 with a mortality of 7 per cent and 257 cases from 1930 to September 1, 1935, with a mortality of 3.9 per cent. In 1,133 operative cases of appendicitis reported by Haggard, the mortality was 2.5 per cent. In a later series of 2,211 cases up to September 1, 1934, the mortality was 3.39 per cent. Gile and Bowler, in reporting 791 operated cases with a total mortality of 1.89 per cent, called attention to the high mortality, 36.4 per cent, in 22 cases of perforated appendicitis with general peritonitis, and a mortality of 6.45 per cent in 93 cases of gangrenous appendicitis with local peritonitis with or without perforation. Collier and Potter reported 336 cases in which there were 14 deaths. There were 85 peritonitis cases that were designated as the deferred operation group with a mortality of 9.3 per cent.

*Intestinal Decompression Through the Natural Channels*—In a short paper on spreading of general peritonitis of appendiceal origin read before the Jefferson County Medical Society in 1917, the writer reported 15 cases with one death. Six of the cases followed intra-abdominal rupture of appendiceal abscesses. They were all operated upon and all recovered. The following case represents fairly accurately this group of the series.

**Case 15**—Elvin H., white, male, age 11. Admitted, Hillman Hospital, October 25, 1917. An older brother had died of a similar attack six months before following an operation for it. Present illness began with a chill, pain in abdomen, nausea and vomiting weeks before admission to hospital. On admission Temperature 99.3/5°F. Pulse 102. Respiration 28. Urine negative. Leukocyte count 8,600. Abdomen greatly distended, rigid and very painful on palpation. Diagnosis General peritonitis. Patient was immediately operated upon. Operation—Right rectus incision. A large quantity of thick pus, which seemed to fill the entire abdomen, escaped. A ruptured necrotic mass was well up under the liver. This represented a ruptured retrocecal appendiceal abscess. A small stump of the ruptured gangrenous appendix was in the center of this mass and large fecal concretions or stones were in the mass. The stump of the appendix was ligated and amputated and buried with a catgut purse string suture. Free drainage was provided. The boy was nervous and emaciated when he underwent the operation. He had attacks of convulsions and his recovery was slow, but he finally recovered. He was well and went home six weeks after the operation.

Nine of the cases had a spreading of general peritonitis due to ruptured appendix. All recovered except one. The following case is representative of this group of the series of patients.

**Case Report**—Paul P., Negro, male, age 13. Admitted, Hillman Hospital, April 27, 1915. Complaint Generalized pain in abdomen. Present illness began with a chill seven days before admission. Patient was nauseated and vomited at intervals. Had high



temperature and pain in abdomen. Bowels had moved once or twice daily. On admission Temperature  $102\frac{1}{5}^{\circ}\text{F}$ . Respiration 54. Pulse 144. Abdomen greatly distended and tympanic, no marked tenderness on pressure. Urine negative, leukocyte count 12,000, heart and lungs negative. Diagnosis: General peritonitis. Patient was operated upon immediately. Operation—On opening the abdomen, a copious quantity of pus escaped. A large necrotic ruptured appendix was removed and free drainage provided for. Patient was well and went home four weeks after operation.

In operating upon these cases, light ether or gas oxygen anesthesia was used and usually the McBurney incision. Free drainage was provided by the use of light cigarette and soft fenestrated rubber tubes, one of each in the pelvis and the kidney pouch. The patient was placed in the Fowler position and on the right side, extreme semiprone position, the left knee flexed. The back supported by a pillow. This semiprone, right side position was maintained constantly 24 hours when the patient could be on the right side or turned slightly to the left at intervals but not on the back or left side under any circumstances. The dressings were changed frequently. The stomach was washed out if indicated, before or after the anesthetic was given. Hypodermoclysis of normal salt solution or intravenous normal salt was given as indicated. The intestinal distention was relieved by starting the Murphy drip immediately after the operation, using a large size male catheter. Every 30 minutes or hour, or at frequent intervals, the rubber tube, with a length sufficient to reach the drainage bottle or receptacle on the floor attached to the glass nozzle connected to the normal salt container, was detached and lowered to the drainage receptacle, and in this manner, the gas and intestinal contents were removed by siphonage. It was found that intestinal drainage would be established almost immediately. The Murphy drip and the siphonage may be carried out by the use of the indicated rubber tubes attached to a Y tube, the clamps attached to the rubber tube connected with the normal salt or irrigating container and the rubber tube leading to the drainage receptacle being alternately tightened or loosened. The distention would become gradually less and the part of the abdomen distal to the drain would within a short time, six to 24 hours, become soft and comparatively painless. The writer's idea is that by this method of intestinal decompression through the natural channels, the toxins are removed from the intestinal tract and the intraluminal and intramural pressure is relieved and the necessary fluids are supplied. It is found that by this method it is rarely necessary to wash out the stomach. The drainage tract becomes a walled off open abscess. The cigarette drain may be removed or removed gradually after three to five days and the rubber tube can be removed gradually. If the toxins are being absorbed from the drainage tract as indicated by subnormal or elevated temperature, it is irrigated once or twice per day using a Luer syringe with a male catheter attached, which can extend to the bottom of the drainage tract. The drainage tube provides for the outflow of the normal salt or other irrigating solution. Aseptic and antiseptic technic should be scrupulously observed.

The writer has used the above method of treatment in more than 1,000 operated and non-operated cases of peritonitis of pelvic origin with less than 1 per cent mortality and in a large number of cases of peritonitis of appendiceal origin with a low mortality. The following cases are typical cases of spreading or general peritonitis.

**Case Report**—Mr A C B, South Highland Hospital April 14, 1925. In consultation with Dr J D Heacock, I saw this patient at 3 30 P M. The night before, he was awakened with severe epigastric pain, nausea and vomiting, and the following day about noon, he had a very tender mass in the right iliac region. The symptoms had not abated up to the time Doctor Heacock asked me to see the patient. However, when I examined the patient, he was perfectly comfortable and smoking a cigarette. He said he was not sick, that he was entirely relieved and he was going to get up and go to town. I agreed with Doctor Heacock in his diagnosis and I told the patient that his appendix had ruptured and that he should be operated upon immediately. He declined. Doctor Heacock was advised of my conclusions and I made the suggestion that the patient be given absolutely nothing to relieve any pain which, I was sure, would develop shortly. At 3 A M the following morning (about 12 hours after his appendix had ruptured), I was told that the patient was in the South Highland Infirmary and seemed to be in the greatest agony. His abdominal muscles were intensely rigid. There was cold perspiration and he thought he surely was going to die. I advised immediate operation. His wife insisted that I wait until her mother could arrive at 9 30 the next morning. Thus I declined to do. I operated upon him under gas-oxygen anesthesia through a right rectus incision, and a copious quantity of pus exuded and was aspirated from the abdominal cavity. Soft rubber tubes and cigarette drains were placed in the pelvis and in the kidney region next to the abdominal wall and covered by omentum. The treatment was carried out as outlined in such cases. He was well and went home in three weeks. However, he developed a hernia at the site of drainage for which I successfully operated three months later.

**Case No 37406**—South Highland Infirmary, Miss M B B, age 25. Admitted November 13, 1925. Diagnosis on admission. Ruptured appendix with spreading or general peritonitis. Present attack began November 11 with cramping pain in abdomen which became localized over McBurney's point with nausea and vomiting. Had for a number of years recurring attacks of indigestion and of abdominal pain. On admission. Temperature 101.8°F, pulse 100, respiration 20. Physical examination was negative except distention and rigidity over entire abdomen, tenderness was greatest over right lower quadrant. Blood pressure 135/60. Leukocytes 13,750, lymphocytes 2 per cent, neutrophils 96 per cent, transitional 2 per cent, urine negative. Operation—November 13, ether anesthesia, McBurney incision, large quantity of free pus in abdomen, which was aspirated. The ruptured appendix was removed, stump invaginated with purse string, two cigarette drains were placed—one in the right pelvis, one in the kidney region, two pieces of gauze in either angle. Pathologic report. Appendix ruptured and showed dark brown fecalith 1.3 cm in its greatest measurement. The fecalith was laminated and calcareous. Diagnosis. Gangrenous ruptured appendix with fecalith. Patient discharged December 22, 1925, with slight drainage from incision but practically well.

**Case No C-4108**—St Vincent Hospital, Mr H L T, age 44, physical director, Birmingham City Schools. Admitted September 19, 1926, discharged October 10, 1926. Diagnosis on admission. Ruptured appendix with spreading or general peritonitis. Diagnosis on discharge. Ruptured gangrenous appendix with extensive area of gangrenous cecum, and spreading or general peritonitis. Present attack. Began Wednesday night, four days before admission, with sudden pain all over the abdomen. Patient had been to a picture show and on returning home had a large watery bowel move-

ment He had not taken any purgative, but the next morning he took a large dose of Epsom salts and a bottle of citrate of magnesia The pain became somewhat relieved in 36 to 48 hours Friday morning, the second morning after the night of the initial attack, at 11 P M, he had a chill followed by fever He continued having fever and pain in the abdomen He had similar attacks in January and April, 1926 On admission Temperature  $101^{\circ}\text{F}$ , pulse 84, respiration 26, abdomen distended and exquisitely tender Laboratory findings Leukocytes 10,200, lymphocytes 13 per cent, large mononuclears 3 per cent, neutrophils 84 per cent, urine negative Operation Patient was operated upon one hour after admission Gas-oxygen and ether anesthesia, McBurney incision, muscles not cut but widely separated, long gangrenous appendix with multiple ruptures removed Appendix base and large area of cecum invaginated with two layers catgut sutures Two cigarette and two tube drains placed—one in pelvis and one in kidney pouch Gross findings Ruptured gangrenous appendix with extensive area of gangrenous cecum Free foul smelling pus in abdominal cavity Patient was well and went home in 21 days

Not infrequently patients are sent in in whom a diagnosis has been made of acute appendicitis and yet the symptoms are so atypical that the diagnosis is uncertain until the patient is thoroughly studied This is especially true in pelvic appendicitis Patients with pelvic inflammatory diseases also have an appendix and some of these cases may have acute appendicitis which finally ruptures, producing general or spreading peritonitis in addition to the peritonitis of pelvic origin The writer has operated upon a number of such cases with acute appendicitis, ruptured and unruptured limiting the operation to the appendix and drainage Cases of pyelitis or urethral stricture may be referred with a diagnosis of appendicitis, and all the symptoms may be due to the urologic condition or the urologic condition may be present and the acute appendicitis also Such patients should be carefully studied and be operated upon when, and if, indicated The writer has had two cases of acute appendicitis in women with pulmonary tuberculosis, in each of whom pyelitis was also present One case had a purulent pelvic appendix and the other had all the symptoms of acute appendicitis with pyelitis, and after consultation with a urologist and an able surgeon, it was decided that there was surely an acute appendicitis which should be operated upon without delay The appendix, when removed, was designated by the pathologist as chronic The patient, however, improved rapidly after the operation, whereas she had grown progressively worse previously

In all the series of cases studied by the writer, it is clearly evident that peritonitis due to appendicitis, be it local, diffuse, spreading or general, is the real cause of the marked mortality due to appendicitis To prevent peritonitis of appendiceal origin is the real appendix problem, and to do this there must be an early diagnosis and an appendicectomy before the infection extends beyond the appendix wall The cases of appendicitis with complications—diffuse, spreading and general peritonitis and appendiceal abscesses—are the ones that test the judgment and skill of the greatest surgeons and they (the surgeons), the patients and the family of the patients, have, do and will continue to recognize the saving of lives in such cases, as entitling surgery to

the designation "The Queen of the Arts" and the surgeons who render the service as masters of the science and art of surgery

The cases reported in the following series are all operative cases. The operations were performed by the members of the staff of each hospital. All cases were private except those in the Hillman.

#### HILLMAN HOSPITAL APPENDICITIS CASES 1913-1925 (Inclusive)

			Per Cent
Number of cases		1,664	
Number admitted with incorrect diagnoses	No operation	260	16.67%
	Number of Cases	Per Cent of Total Cases	Number of Deaths
Appendicitis, acute (with abdominal complications of appendiceal origin, all of which were drained)	616	43.87	91 14.7%
Appendicitis, acute (clean—not drained)	788	56.12	1 0.0012%
Total operated cases	1,404		92 5.73%

COMMENT—(1) It was thought that the number of cases for the period would be much larger but this was due to the length of time the complicated cases remained in the hospital (3 to 6 weeks), and the nursing and professional care given them.

(2) The high mortality in complicated cases.

(3) The low mortality in the clean undrained cases.

(4) The large number of incorrectly diagnosed cases admitted to the hospital.

(5) The clean case that died was a preoperatively undiagnosed case of *Endameba histolytica*. Endamebae were found in the appendix wall, and on autopsy multiple cecal ulcers had ruptured and there were multiple amebic abscesses in the liver.

#### HILLMAN HOSPITAL APPENDICITIS CASES January 1, 1931-October 1, 1936

Number of Cases	Type	Non-drained	Abscess	Local Peritonitis	General Peritonitis	Deaths	Year
233	Acute	224	13	0	12	8	1931
41	Chronic	40	0	0	1	1	1931
274		264	13	0	13	9	Total for 1931
301	Acute	298	27	0	6	12	1932
83	Chronic	80	2	0	1	1	1932
384		378	29	0	7	13	Total for 1932
276	Acute	269	30	0	8	4	1933
41	Chronic	0	3	0	0	2	1933
317		269	33	0	8	6	Total for 1933

# THE APPENDIX PROBLEM

## HILLMAN HOSPITAL APPENDICITIS CASES—*Continued*

Number of Cases	Type	Non-drained	Abscess	Local Peritonitis	General Peritonitis	Deaths	Year
272	Acute	260	23	6	12	11	1934
96	Chronic	95	0	0	0	1	1934
368		355	23	6	12	12	Total for 1934
275	Acute	251	37	15	17	24	1935
79	Chronic	78	1	0	0	1	1935
354		329	38	15	17	25*	Total for 1935
222	Acute	208	11	5	11	17	1936
33	Chronic	32	0	0	0	0	1936
255		240	11	5	11	17	Total for 1936, up to October 1
1,952		1,835	147	26	68	82	Grand total for 6 years

Mortality 4.2 per cent

\* Causes of death for the year 1935

General Peritonitis 13—52%      Local Peritonitis 4—16%      Abscess 6—24%      Appendicitis with myocardial failure and pneumonia 2—8%  
(1 acute appendicitis with myocardial failure    1 chronic with pneumonia)

## WEST END BAPTIST HOSPITAL APPENDICITIS CASES 1931—1935 (Inclusive)

Total number of cases 778

Type of Case	1931	1932	1933	1934	1935	Total Cases
Chronic and subacute	57	30	26	35	45	193
Acute	119	94	75	81	96	465
Ruptured	5	2	2	5	8	22
Gangrenous	21	23	18	13	23	98
Deaths*	3	2	2	3	2	12

\* All deaths were in ruptured gangrenous or suppurative cases

## REPORT OF GORGAS BRANCH FOR FIVE YEARS

Total number of cases 696      Deaths\* 3

\* Two deaths were in the gangrenous suppurative groups and one death in the chronic group

## NORWOOD HOSPITAL APPENDICITIS CASES 1920—1937

Series	Number	Per-cent-age	Days Ill before Admission	Hospital Days	Deaths Number	Per Cent	Cause of Death
1920—1933							
Acute	1,725	67.3			20	1.15%	
Subacute	243	9.6			0	0	
Ruptured	220	8.3			19	8.63%	
Chronic	354	14.8			0	0	
Total	2,542	100.0			39	1.10%	
Series 1933—1937							
Acute	221	29.9	18.7	8.4	3	1.35%	2 Pneumonia 1 under anesthetic

NORWOOD HOSPITAL APPENDICITIS CASES—*Continued*

	Number	Per- cent- age	Days Ill before Admission	Hospital Days	Deaths Number	Per Cent	Cause of Death
Gangrenous	140	18.8	36.2	10.3	1	0.71%	1 under anesthetic
Ruptured	25	3.5	56	18.5	2	8.00%	Peritonitis
Abscess	20	2.5	120	15.3	0		
Subacute	141	19.0	34.6	7.8	0		
Chronic	69	9.4	105	8.4	0		
Removed at other oper- ations	126	16.9			1	0.80%	Unde- termined
Total	743	100.0		7	7	0.94%	

1920-1937

Total	3,285				46	1.40%	
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## SOUTH HIGHLANDS INFIRMARY APPENDICITIS CASES 1934-1936

	Number	Number with Peritonitis	Deaths	Per Cent
Appendicitis, gangrenous and per- forated	117	2	4	3.4%
Appendicitis, with abscess	20	1	4	20.0%
Appendicitis, acute	451	1	3	0.66%
Appendicitis, chronic (recurrent)	473	0	2	0.4%
Total	1,061	4	13	1.2%

## ST VINCENT'S HOSPITAL APPENDICITIS CASES 1932-1936

	Number	Number with Peritonitis	Deaths	Per Cent
Appendicitis, gangrenous and per- forated	180	2	2	1.1%
Appendicitis, with abscess	58	0	1	1.7%
Appendicitis, acute (1 of these pa- tients had a pulmonary embolus)	641	1	2	0.32%
Appendicitis, chronic	576	0	2	0.5%
Total	1,455	3	7	0.5%

## CONCLUSIONS

(1) Intensive study by surgeons is being given to appendicitis and the mortality due to appendicitis is being markedly reduced as shown by the records of official statisticians and by the reports of large numbers of cases from many general and private hospitals and by individual operators

(2) The mortality in the acute uncomplicated cases of appendicitis where the infection is limited to the appendiceal wall is very small, less than one half of one per cent

(3) Cases of appendicitis with complications are the ones in which a mortality is likely to occur. More than 90 per cent of the mortality in most series of cases reported is due to some form of peritonitis.

(4) Some surgeons report as good results with the immediate operation after the indicated preparation of the patient as other surgeons do by the deferred operation with the indicated treatment. It is possible that the lack of agreement among surgeons relative to the two procedures—the immediate operation after the indicated preparation and the deferred operation with the indicated treatment—is more apparent than real. It is generally recognized now by surgeons that every patient should be properly prepared before an operation is performed, and this preoperative preparation and treatment may be what some regard as the deferred operative procedure.

(5) A broad, comprehensive, continuous, orderly, ethical, educational campaign, with reference to appendicitis as a widely prevalent disease, should be conducted by the national, state, county and city health authorities and by the schools, colleges, universities and industries throughout the country.

#### REFERENCES

- <sup>1</sup> Keves, E. Laurence. Death from Appendicitis. The Mortality from Appendicitis and the Causes of Death Following Appendicitis. *ANNALS OF SURGERY*, 99, 47, 1934.
- <sup>2</sup> Finney, J. M. T. Appendicitis. *Surg., Gynec. and Obstet.*, 56, 360, 1936.
- <sup>3</sup> Love, R. J. McNeill. Treatment of Acute Appendicitis. *Lancet*, 1, 1229, 1933.
- <sup>4</sup> Von Zwalenbug, C. V. Strangulation Resulting from Distention of Hollow Viscera. *ANNALS OF SURGERY*, 46, 780, 1907.
- <sup>5</sup> Maes, Urban, *et al.* Acute Appendicitis after Forty with a Clinical Review of 100 Cases. *Am Jour Surg.*, 23, 157, 1934.
- <sup>6</sup> Richardson, Maurice. Remarks Upon Appendicitis Based Upon a Personal Experience of 180 cases. *Am J Med Sci.*, 107, 1, 1894.
- <sup>7</sup> Guerry, LeGrand. Discussion of Shipley and Bailey's Paper on the Treatment of Appendicitis Complicated by Peritonitis. *ANNALS OF SURGERY*, 96, 537, 1932.
- <sup>8</sup> Royster, H. A. Appendicitis. New York, D. Appleton & Co., 1927.
- <sup>9</sup> Maes, Urban, *et al.* Acute Appendicitis in Childhood. Clinical Analysis of 250 Cases. *Surg., Gynec. and Obstet.*, 58, 32, 1934.
- <sup>10</sup> Nuttall, H. C. Wardlesworth. The Fallacy of Expectant Treatment in Acute Appendicitis. *Brit Jour Surg.*, 21, 411, 1934.
- <sup>11</sup> Sherren, Jas. Appendicitis. *Brit Med Jour.*, 1, 727, 1925.
- <sup>12</sup> Berry, Sir James. "Fallen Idols," The Case of Appendicitis. *Lancet*, 1, 1027, 1932.
- <sup>13</sup> Bailey, Hamilton. The Ochsner-Sherren (Delayed) Treatment of Acute Appendicitis. *Brit Med Jour.*, 1, 140, 1930.
- <sup>14</sup> Haggard, W. D. An Analysis of 3344 Cases, with Remarks on Delayed Operation in Delayed Appendicitis. *Am Jour Surg.*, 71, April, 1935.
- <sup>15</sup> Haggard, W. D. The Unnecessary Operation. "Surgery, Queen of the Arts." W. B. Saunders, 376, 1935.
- <sup>16</sup> Gaither, Ernest H. Advances in Gastro-Enterology, *J. A. M. A.*, 107, 8, 549, August 22, 1936.
- <sup>17</sup> Livingston, Edward M. The Skin Triangle of Appendicitis. *Arch Surg.*, 13, 630, November, 1926.
- <sup>18</sup> Cope, Zachary. Clinical Researches in Acute Abdominal Diseases. Oxford Medical Publications, London, Oxford Press, 1925.

- <sup>19</sup> Hoffman, Frederick L Appendicitis Record of 1935 Reprint from The Spectator November 12, 1936
- <sup>20</sup> Friedrichs, A V The Etiology and Pathology of Appendicitis, New Orleans Med and Surg Jour, 87, 20, July, 1934
- <sup>21</sup> Maes, Urban, *et al* Acute Appendicitis Between the Extremes of Life with Analysis of 910 Cases New Orleans Med and Surg Jour, 87, 24, July, 1934
- <sup>22</sup> Ochsner, Alton The Conservative Treatment of Appendiceal Peritonitis New Orleans Med and Surg Jour, 87, 32, July, 1934
- <sup>23</sup> Horsley, Guy W Improved Treatment of Appendicitis Virginia Med Monthly, 62, 598, January, 1936
- <sup>24</sup> Garlock, John H Acute Appendicitis—Controllable Mortality Factors Am Jour Surg, 23, 248, 1934
- <sup>25</sup> Battle, W H Appendicitis A 50 Years Experience in St Thomas Hospital Lancet, 222, 1276, 1932
- <sup>26</sup> DeCourcy, Joseph L Care of the Ruptured Appendix Surg, Gynec and Obstet, 63, 756-760, December, 1936
- <sup>27</sup> Priestley, James T, and McCormack, Christopher J Generalized Peritonitis Secondary to Rupture of the Appendix Surg, Gynec and Obstet, 63, 675-680, November, 1936
- <sup>28</sup> Cartledge, A Morgan Is Operation Demanded in All Cases of Appendicitis? The Best Time to Operate Southern Surg and Gyn Trans, 85-106, 1893
- <sup>29</sup> Department of Commerce, Bureau of Census, Washington, D C, October 3, 1935, and August, 1935
- <sup>30</sup> Personal Communications with Department of Health, State of Alabama, Montgomery
- <sup>31</sup> Wangenstein, Owen H The Mechanism of the Vermiform Appendix—A Potential Closed Loop Surg, Gynec and Obstet, 20, June, 1936
- <sup>32</sup> Collier, Frederick A Dehydration Surg, Gynec and Obstet, 249, August, 1936
- <sup>33</sup> Orr, Thomas G Edema In Surgical Patients Surg, Gynec and Obstet, 527, October, 1936
- <sup>34</sup> Roberson, Foy Experience with Appendicitis in College Students Am Jour Surg, 201-209, May, 1935
- <sup>35</sup> Guthrie, Donald Appendicitis Mortality Am Jour Surg, 29, 171, August, 1936
- <sup>36</sup> Editorial Reducing the Mortality of Acute Appendicitis J A M A, 106, 25, June 20, 1936
- <sup>37</sup> Gamble, H A The Open Treatment of Peritonitis Secondary to Appendicitis Southern Med Jour, 29, 834-838, August, 1936
- <sup>38</sup> Pool, R M Acute Appendicitis Am Jour Surg, 32, 471, June, 1936
- <sup>39</sup> Reid, Mont R, *et al* Statistical Study of 2,921 Cases of Appendicitis J A M A, 106, 665-669, February 29, 1936
- <sup>40</sup> Boland, Frank K Results in the Treatment of Acute Appendicitis Review of 4720 Cases in Atlanta J A M A, 99, 443, 1932
- <sup>41</sup> Gile & Bowler The Management of Perforated Appendicitis J A M A, 103, 750, December 8, 1934
- <sup>42</sup> Collier & Potter The Treatment of Peritonitis Associated with Appendicitis J A M A, 103, 1753, December 8, 1934
- <sup>43</sup> Stellhorn, Chester E Robert James Graves Am Jour Surg, 28, 183, April, 1935
- <sup>44</sup> Murphy, J B Surgery of the Appendix Vermiformis, Keen's Surgery Philadelphia, W B Saunders Co, 4, 75, 1908
- <sup>45</sup> Robertson, George, F R C S, Edinburgh Disturbed Reflexes Their Significance in Acute Abdominal Diseases Surg, Gynec and Obstet, 806, December, 1926
- <sup>46</sup> Pendergrass, Eugene P The Small Intestine J A M A, 107, 1859, Dec 5, 1936
- <sup>47</sup> Meakins, J C The Practice of Medicine The C V Mosby Company, St Louis, Mo, 1936



DISCUSSION OF PAPERS OF DOCTORS MCCLURE, BUNCH, DOUGHTY AND HOGAN

DR HUBERT A ROYSTER (Raleigh, N C) —These papers are very interesting, and yet they all begin at the wrong end. I have said repeatedly that I would take my chances, and so would you, with a mediocre surgeon if I had an unruptured appendix, rather than have the most expert surgeon at the eleventh hour. The real truth is that none of us pays much attention to the pathology of the disease. The fact is that every acute appendicitis attack that comes to the operating table has been preceded by a pathologic condition going on for at least two years. When we question the patient "Is this the first attack you have ever had?" Ninety per cent of them will say, "Yes," but when he says "first attack" he means the "worst" attack. Appendicitis is a going concern, a continuous process, and the acute attack is not the beginning, but the culmination of the disease. It represents the knock on the door saying, "Let me out." We have become convinced that the mild attacks, so called, do as much damage as the acute attack. It has been shown by Rogers of the New York Life that only 2 per cent of those who have one attack escape others. Once appendicitis always appendicitis, until the little criminal is executed.

It is not up to us to say that these cases cannot be diagnosed, they can, for suspicion is better than cardinal symptoms. When Doctor McClure speaks of 66 per cent of atypical cases, I reply there are no atypical cases. We must go behind the returns. All our educational work is part of this problem. When the patient has the terminal type we have come to the end of the pathology instead of the beginning, because acute appendicitis is, as Dieulafoy said in 1898, an infection of a vestigial organ structure, a pathologic process in a closed tube, and there is no escape for it. Once damaged it is always damaged. So, when we speak of the different forms of appendicitis, even atypical appendicitis, we can say with Hendon, "the only hand that paints a perfect pathologic picture is the hand of death."

DR JOHN T MOORE (Houston, Tex) —I have learned a good lesson from these three excellent papers. I do not know whether any of you will remember our colleague, Dr R T Morris of New York. I have just read with great pleasure "Fifty Years a Surgeon." This book causes me to go back over a lot of things I remembered when Dr A J Ochsner and others were discussing appendicitis. Everything practically seems to have been said about the pathology, the symptoms and so forth, but it all comes back to a few things which I have tried to instill into the minds of the coming surgeons in our State. The first of these is to avoid purgatives before the diagnosis is made. The other one is that after making the diagnosis, there should be an immediate operation, provided you know how to operate properly. Where we run into a discussion, in our country, is in regard to the kind of incision that should be made in acute appendicitis. If these studies show anything in the world it is what Morris called attention to when McBurney and other great surgeons were having a death rate of 10 to 20 per cent, when Morris had a death rate of less than 1 per cent. He used a button hole incision and a finger in the abdomen. We have tried to teach our students that the incision for acute appendicitis is the small McBurney incision. Get the appendix out and never let the ileum come in contact with anything septic. If these studies show anything, it is that 10 to 20 per cent of the cases operated upon were operated after the third day, and then I would be interested in knowing what the incision was. It has been customary with us to operate upon those cases as soon as we see them, but we try not to see anything but the cecum

You can make the McBurney incision far out, and in the majority of cases can get the appendix out without coming in contact with anything but the appendix

The question of drainage has been studied by members of this Association. Some drain and some do not. It has been our custom in the infected cases where we see serum that seems to contain pus, or in the gangrenous appendix, to put in a drain.

We want to teach our younger men that the right rectus incision is an exploratory incision and not an incision for taking out an appendix. If we can get that over, our mortality will be lower. The reason our mortality ran up so high in the past few years was because we stopped emphasizing the particular things that Doctor Finney and some of the others have emphasized many years ago—when to operate and how to operate. Since you have started this discussion again, it is very pleasing to know that the statistics in Birmingham are so very good. I would be interested in knowing how many of these cases are operated upon by highly trained surgeons and how many by general practitioners. In our part of the country our mortality is high because there are so many operations by general practitioners. That must be emphasized to make the mortality lower.

DR ROBERT L SANDERS (Memphis, Tenn.)—I wish to emphasize what Doctor Moore has just said regarding the McBurney incision. Such a procedure is not only time saving, less disabling from the standpoint of post-operative herniae, *etc*, but it is actually life saving in many instances. I am convinced that we have a lower mortality rate in the cases of acute perforated appendicitis when they are approached through such an opening in the abdominal wall.

I go a step farther and leave the gridiron wounds completely open in all badly infected cases. When the appendix is perforated and free pus is in the abdominal cavity, the appendix may or may not be removed according to the indications. Penrose drains are placed in the wound, the peritoneum loosely closed about them to prevent the escape of intestinal loops, and the muscles, fascia and skin are left open—no sutures being used. Pus follows lines of least resistance and comes to the surface unobstructed. Such wounds soon clean up, no fascia is lost, and healing is usually prompt and complete—herniae are rare—secondary closures are seldom necessary. To hasten the recovery, wounds may be drawn together by adhesive strips after the infection has subsided. In contrast to this procedure, one may close the muscles, fascia and skin about the drains and observe pus burrowing beneath the fascial planes, infecting and devitalizing all structures. About the fifth day, a large swollen area may be present, and when the sutures are removed, foul infected fluid will escape, and dark fascia may be seen for a distance of several inches. For days, and even weeks, strips of dead fascia may be removed, leaving a gap that is not easily bridged, potential, if not actual, herniae may result. Doctor Bunch mentioned loose closure of the wounds. In our cases we have found it much better to refrain from using sutures at all, for the above reasons. Some years ago, Doctor Bancroft read a paper in which he advocated nonclosure of such infected wounds. He studied the incidence of postoperative herniae and found them much less when no sutures were used in the abdominal wall. Our mortality has been materially reduced since we adopted this method of treatment.

One other point in regard to Doctor McClure's paper. I thoroughly agree with him in the use of pitressin in cases of acute perforated appendicitis.

with peritonitis. Intestinal muscle tone is kept up, ileus is not so marked, and distention is prevented in almost all cases in which it is used. We give one cubic centimeter subcutaneously when the anesthetic is started, repeat it in two hours after the patient has been returned to bed, and then every four hours until six doses are given. We have been much pleased with the effect.

DR R. S. HILL (Montgomery, Ala.)—I feel safe in saying the progress of American surgery has been satisfactory and gratifying in every respect except in the reduction of the mortality from appendicitis. This is particularly regrettable in that there is no other surgical condition of greater practical importance. Through the many years since the epoch making article by Reginald Fitz (1886), fixing the minds of the profession on appendicitis, the "what," the "how" and the "when" to do have been discussed without a satisfying result in reducing the mortality from the disease. It is not my purpose to discuss the "what" and the "how" to do, but the "when" to do—to operate. I am convinced that the death rate from appendicitis will be materially lessened if these patients are more promptly brought to operation.

Let it be gotten over to the nonsurgical medical men that appendicitis is a distinctly surgical disease which, in the absence of some definite individual contraindication to operation, calls for prompt surgical intervention and that efforts to avoid operation are unwarranted and dangerous. Furthermore, in the exceptional case, in which a positive diagnosis cannot be readily made, the surgeon should have the moral courage to operate on a probable diagnosis rather than subject the patient to the great danger of suppuration from delay in an effort at refinement in diagnosis.

To drive home the thought I have, permit me to draw from material furnished by Doctor Finney in the report—in his own inimitable way—of two patients to this Association a few years ago. Having been called out of the city to perform an appendicectomy, he said, after the operation, to the doctor in charge, "Doctor, if and when you find out what is the matter with this child will you wire me at my expense?" The next day he received a one word telegram "Measles." With this case fresh in mind, he was called to operate upon another child. He asked if the patient had been exposed to measles. He had been, and in fact, "There is a case in the house now." "Well," said Doctor Finney, "we will wait developments." A pus appendix was the result. Now if, on the theory, "it is human to err," I may have the temerity to use the word error in connection with Doctor Finney's surgical work, I would say he did not make a surgical error in the first case, for his operation added little to the danger and prevented what possibly might have been a serious risk as exemplified in the outcome in the second patient.

Many years ago, Doctor McBurney operated upon the wife of a friend of mine for gallstones and found no trouble with the gallbladder. It was one of those cases discussed by Dr. Maurice Richardson, who, by the way, seemingly preferred talking of his mistakes rather than his successes, in a paper entitled "Operating for Gallstones When There Are No Gallstones." The husband objected to paying Doctor McBurney's bill, as no gallstones were found. Doctor McBurney replied, "Why, my good fellow, it is worth that much to know your wife has no gallstones—with this trouble eliminated we can better discover and treat the condition causing your wife's ill health."

In what I have said, do not understand me as advocating the reckless removal of the appendix or of underestimating the desirability of an accurate diagnosis. I am simply advocating prompt operation—giving the patient the best chance to recover, even though there is a possibility of an occasional unnecessary appendicectomy being performed.

DR ROY D McCLURE (closing) —Our hat is off to North and South Carolina for, as the first table indicated, they have the lowest mortality rate in the United States from appendicitis

I was interested in Doctor Royster's remarks, that we in our discussion do not go back far enough. In the past nine years through the work of our assistants in the Medical Division at the Ford Rubber Plantation in Brazil, we have had the opportunity to study the statistics on several thousand natives living and working in primitive conditions in the jungle

Not a single case of appendicitis developed during the first year, but each succeeding year has shown a definite increase in the incidence of acute appendicitis, and at the present time cases of gangrenous appendicitis are not uncommon. The living conditions of these employees have steadily improved according to our standards of living. The most noticeable change has been in the food habits and this has been the substitution of fresh meat and canned goods for the usual native diet of fruit and fish

Some years ago I remember the tendency to scoff a little at statistical studies and it was not infrequently stated that "statistics could be made to prove anything." However, I feel sure that the ultimate decision of the surgical world as when to operate on the patient with a perforated appendicitis and peritonitis can only be made by the honest and accurate comparison of statistical studies. At this meeting, in which each of us set forth our results for your study and consideration and the exchange of ideas and experiences in this discussion, are steps toward reaching that ultimate decision. The expectant or Ochsner method of treatment might be better in some of the older group of patients where abscess formation is more apt to occur. Again it might not be so good in children where an abscess is not so apt to occur, as is shown in our series of cases

Perhaps when the American Board of Surgery for the certification of surgeons being set up by the Southern Surgical in cooperation with other leading surgical societies is instituted, the mortality rate will decrease. At least that is the worthy aim and hope of this association and the other surgical societies. This could not come in our generation but we can set up certain standards in surgical training and practice which may very well bear fruit in the next generation in which our children and grandchildren must live

## EPIGASTRIC SYMPTOMS IN ACUTE LUNG AND HEART DISEASES

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RECENT medical literature shows that there is a renewed and active interest in the general subject of acute pain in the upper abdomen. The newer conception of cardiac pathology in reference to angina pectoris and coronary disease has been reflected in widespread study of the meaning and interpretation of severe epigastric pain. Although Heberden, in 1768, wrote a very clear and concise description of coronary sclerosis, and before him Jenner won a wager with another physician that his patient died from the disease, the pathology of coronary disease was forgotten or overlooked until about 1912, when adequate descriptions and case reports began to appear in German medical literature. Heirick,<sup>2</sup> in 1912, wrote the first report giving convincing evidence. Prior to this, Dock, in 1896, recognized a case and proved it by autopsy. Osler,<sup>3</sup> in 1910, understood the pathology of coronary thrombosis and described accurately the significance of the associated epigastric pain.

A brief review of the text-book literature of this period shows that the relation between cardiac disease and upper abdominal pain was not understood nor described. Hirschfelder,<sup>1</sup> in the third edition of his book published in 1918, Mackenzie,<sup>4</sup> in 1917, and others of equal eminence do not mention the subject. Among the surgeons may be mentioned Walton,<sup>5</sup> who does not speak of the heart when describing upper abdominal perforations, Cope,<sup>6</sup> as late as 1935, omits any mention of the heart when writing of the diagnosis of the acute abdomen. However, Vaquez,<sup>7</sup> in 1924, a medical writer, gives a very comprehensive and complete description of the pathology and the symptomatology of the accepted views of the heart diseases which exhibit symptoms in the upper abdomen. Cecil,<sup>8</sup> in 1934, gives the symptoms accurately but does not emphasize the importance of the symptoms in differentiating between a medical and a surgical case. LeCount,<sup>9</sup> in 1918, gives a study of the pathology which is very complete and lays down the basis for the symptomatology of coronary sclerosis and thrombosis. It has long been known that aortic disease, under some conditions, produces severe epigastric pain which may resemble in every detail the pain of coronary obstruction. This is also true of aortic aneurysm, disease of the cervical spine,<sup>10</sup> and Salzmann<sup>11</sup> reports from cases of ruptured heart and cases of ruptured aneurysm which presented epigastric symptoms suggestive of a perforated viscus.

*Embryology and Anatomy*—In the second week,<sup>12</sup> the embryonic cell mass divides into three systems, *i e*, entodermal, ectodermal and mesodermal, from which the structures of the body develop. In the third week, the celomic

cavity forms, which is the primitive representation of the pleural, peritoneal and the pericardial cavities in the adult. This is produced by division into two layers of the mesoderm, the inner of which in association with the layer of entoderm forms the *splanchnopleure* and an outer wall in association with a layer of ectoderm forms the *somatopleure*, these membranes enclose the abdominal and thoracic cavities.

In the fifth week, the heart and lungs have been formed and occupy a position in the neck, the lungs above the heart. They lie beneath the chin and the larynx, during the next three weeks, the heart passes from a sub-pharyngeal position to the adult position in the chest. The lungs follow the heart downwards but remain above it. While this is taking place, the neck elongates and the heart lies about the middorsal region of the spine with the lungs on either side of it. All of the connecting structures in the chest become elongated to conform to the heart and lungs, *ie*, the esophagus, the trachea, vagus nerves, jugular veins and carotid arteries.

The embryology of the lungs is more complicated than that of the heart. In the earliest stages of development, the lungs are represented by the branchial system which has to be completely changed into an air breathing system. The changes are going at the same time as the development of the heart and are becoming cooperative. The lungs arise from the analogue of the swim bladder in fishes and during the fifth week it is bifid, each half being properly called a lung. They lie in the abdominal cavity above the heart and the liver, a respiratory passage develops, leading from the pharynx to the lungs, and a vascular system develops, an artery to each lung, from the sixth visceral arch. The branchial muscles which formerly forced water through the gill slits now become pharyngeal muscles and pump air into the lungs, acting as muscles of inspiration. The muscles of the body wall are formed into muscles of expiration. They are formed from the primitive muscle sheets, two of which are of interest, namely, the transversalis sheet which arises from the spine and ends in the pericardium, esophagus, and the roots of the lungs and the deep lamina of the rectus abdominis muscle which ends in the pericardium, the first of which becomes the diaphragm. The nerves supplying these muscles come down along the vena cava. At this stage, and following, the diaphragm develops and separates the chest viscera from the abdominal and the diaphragm becomes an organ of inspiration. A striking factor is that as the heart and lungs descend, they carry with them their original nerve supply and a modified vascular supply. In the sixth and seventh weeks, there is rapid expansion of the lungs downwards with the development of the celomic cavity.

The nervous system, the parasympathetic, which supplies the heart and lungs comes from the basal centers and descends with the organs. The symptoms, arising from disease of these viscera, radiate over regions of the body that are not supplied by the basal nerves but these have connections with the sympathetic nerves and their ganglia which explain their distribution. This explains the segmental character of the symptoms which are located in the body wall, in the epigastrium and in other regions of the body.

*The Nerves Directly Concerned with Cardiac Function*—The brief description by Heilmann<sup>11</sup> is recommended for its clarity and correctness, *i.e.*, "The most recent work seems to indicate that the important efferent tracts from the deep cardiac and aortic plexuses lead through the sympathetic connections and chain from the fourth to the first thoracic ganglia and their respective posterior spinal roots

"The intricate network of nerve fibers and ganglion cells is spread over various tissues about the great vessels and the heart. From the base of the aorta fibers are to be found spreading down along the coronary arteries and their branches just beneath the epicardium. The fibers and plexuses are of autonomic and sympathetic origin coming from the vagus, the recurrent laryngeal, the superior, middle and inferior cervical, the stellate ganglia, the inferior middle and superior cardiac nerves, the first to the fifth thoracic ganglia, then rami and the posterior spinal roots."

The nerve supply both to the heart and lungs is very intricate and confusing, but the clinical interest is centered in the distribution of pain and muscle disorganization in the coverings of the upper abdomen. The problem becomes very simple when stated in these terms. Nausea and vomiting, as well as suspected pain in the viscera, may be due to reflex action through the vagus, combined ganglia and the sympathetic nerves on the muscle walls of these organs.

*The Clinical Distribution of the Pain Impulse*—The type and character of pain and its distribution to the epigastrium are the features of every case, first to attract the attention of the examiner. It is only when the pain during a supradiaphragmatic illness is reflected into the upper abdomen that the case becomes of surgical importance.

The vagus and the sympathetic nerves which supply the chest viscera are connected with abdominal musculature indirectly, the connection is central and through the ganglia of the sympathetics which connect with the segments of the spinal cord which excite the areas in the cord supplying the intercostal nerves that supply the musculature of the abdomen. Keith<sup>12</sup> says that undoubtedly the cord was segmented in very early evolutionary life. There is no question about functional segmentation which is expressed clinically in these cases under discussion. The essential nerve supply of the heart and lungs is from the basal centers which extend downwards as the vagus, the opposing system, the sympathetic, with its interminable connections between the ganglia, the many medullated and nonmedullated fibers connecting both systems, is distinctly segmented. The efferent nerve branches carrying impulses to and from the diseased areas reach the cord segmentally and the distribution of these painful impulses are through efferent fibers which transmit both pain and motor stimuli to the abdominal muscles. While it may be true that there are similar connections between the vagus and the sympathetic nervous systems supplying the epigastric viscera, the type of pain is not that which is seen in the abdomen during acute disease of these organs. In acute intestinal obstruction, acute appendicitis, acute pancreatitis and similar affec-



tions, *uncomplicated* disease of these organs is not attended by rigidity or marked tension of the abdominal muscles. Not until the parietal peritoneum has become affected does the musculature become rigid or even tense. Illustrative instances are impacted gallstones, the early stages of appendicitis, intestinal obstruction, *etc*.

During an attack of severe pain from any cause, there is always more or less general muscle tension all over the body, the patient holds his breath, clinches his hands, gazes intently, lies in a tense position, *etc*, with greater tension in the region of the pain, or he is frantic and tossing, but always tense.

In acute inflammatory diseases of the abdomen, the area of peritoneum involved is always beneath the region of muscle tension, there is a definite connection between these occurrences, the pain is localized with tenderness and muscle tension. But, as long as there is no peritoneal irritation, as is so notable in the splanchnic stage of acute appendicitis, there is no muscle reaction. In other words, it requires peritoneal irritation to provoke muscle spasm and tension in the acute inflammatory diseases of the viscera. On the other hand, there can be moderate muscle tenderness, moderate rigidity and any degree of pain in the muscles of the upper abdomen which are supplied by nerves which are irritated either in the cord segments or along the fibers above the diaphragm. Since no one claims that the peritoneum lining the epigastrium or covering the viscera is irritated by the pathology above the diaphragm there could be no true muscle rigidity. The nerves concerned with the muscle tension and pain in the upper abdomen are the intercostals from the sixth, seventh, eighth, ninth, and tenth. The pain and tension are protective and defensive in their functions, since there is nothing to protect in the upper abdomen—the disease being above the diaphragm—the technic of examination as described elsewhere in this paper should differentiate between what is real and what is apparent.

*Acute Inflammation of the Lungs and Pleura*—The patient is suffering from pain in the epigastrium which is of such gravity as to demand a differential diagnosis from some acute pulmonary ailment. There is usually nothing in the general symptoms to determine the reason for the epigastric findings, the temperature, pulse rate, appearance of the patient, type of breathing and the history are those of some acute infection.

The usual symptoms of pneumonia, such as high fever, pain in the affected side, rapid breathing, cough and limited diaphragmatic action, especially on the side involved, are noted. The significant and only symptoms of any importance are epigastric pain, muscle tension, and tenderness, these may be of any degree, from mild pain and tenderness to great severity, the muscle tension is never to the degree of rigidity. There is always the possibility that the patient is suffering simultaneously from pneumonia and some acute abdominal affection such as acute cholecystitis, acute appendicitis, acute pancreatitis, *etc*. The patient with pneumonia almost always gives a history of some pulmonary disturbance as the inaugural trouble.

The diagnostic differences between the muscle tension of lung affections



and peritonitis are that the muscle is never in marked or definite spasm. Gentle palpation will disclose some measure of relaxation between the respiratory movements, never in muscle rigidity, voluntary relaxation is possible with tension, never with rigidity, cutaneous tenderness and muscle tenderness may be identical in both conditions, deep tenderness, elicited by pressure with the flat hand increasing with attempted muscle relaxation, is absent in pneumonia, it is present in muscle tension from peritonitis. Percussion is of minor clinical significance as a differential diagnostic measure. The characteristic muscle fixation of the abdomen is not present in any lung affection, *viz* pneumonia, lung abscess, pulmonary infarct, pleurisy, *etc*. The abdominal signs and symptoms often met with in acute lung diseases are limited to the muscle wall and the problem in diagnosis is to bring out these features. I think that it can be made with great certainty. If the patient is suffering from two distinct diseases, pneumonia and appendicitis, for instance, the history of the onset and the chronology of pain will furnish all the required evidence for making the correct diagnosis in both instances as the symptoms are superimposed, but quite different. There is rarely, if ever, in acute infections of the lungs and pleura, or the sudden and tragic onset of epigastric pain as is the rule in cases of angina pectoris and coronary thrombosis.

*Acute Cardiac Emergencies, Angina Pectoris and Coronary Thrombosis*

These patients present quite a different clinical picture from the pneumonia patients. The onset of pain is usually sudden, very tense, located both in the left chest and in the epigastrium with radiations into the shoulders, arms, the neck, *etc*, and is unrelieved by the ordinary doses of morphine or other drugs. There is often nausea, vomiting and respiratory distress. Here, as in the lung cases, the differential diagnosis is limited to the area of the upper abdomen. In some cases, the area of pain may be limited to the epigastrium and upper regions of the abdomen. The history may reveal a cardiac patient, but, as elsewhere, the patient may be suffering from two coincidental ailments, one of which is medical and the other surgical, and demanding immediate surgical attention. In this light, the diagnosis becomes of urgent importance.

In some instances of acute epigastric surgical emergencies, the symptoms may be reflected into the chest and confuse the examiner. But, in the painful cardiac diseases, they present such characteristic signs and symptoms that attention to the heart is mandatory. Among these are the absolute quiet of the angina pectoris patient in contrast to the restlessness of the coronary case, this, alone, should make the examiner alert because this condition of the patient is the characteristic attitude of the patient suffering from a perforated viscus. The patient with coronary thrombosis is restless and difficult to control in contrast to both the angina pectoris patients and those with a perforated viscus. There is often nothing characteristic in the heart examination of the angina pectoris case, but there may be evidences of a diseased heart in coronary thrombosis. The condition of the heart must, therefore, be carefully determined before a decision is reached. When the suspicion of the examiner is aroused as to the heart, the way is then made easy for the study of the abdom-

mal evidence. Shock may be of any degree in either cardiac or abdominal patients.

Here, too, as in the examination of the upper abdomen in acute diseases of the chest, the whole problem is simplified into the determination of muscle tone, tenderness, and pain. In perforation of the duodenum or stomach or the rupture of the gallbladder, the onset of symptoms is as sudden and as severe as coronary thrombosis or angina pectoris. This feature is characteristic of all three diseases. But, here, the similarity recedes and, with time, the symptoms pursue a different course. The suddenness of the pain of angina pectoris and coronary thrombosis is associated with terrifying sensations of impending death, pressure in the chest, dyspnea, radiation of the pain into the upper chest, into the arms and shoulders, or into the neck, whereas, while there may be moderate reflection of pain into the chest, there are not the same psychic and mental fears induced by the pain of a perforated viscus as in cardiac tragedies. There may be nausea and vomiting, abdominal distention, some degree of shock, muscle tension and tenderness with fever in coronary thrombosis, but the cardiac examination will, in the absence of definite muscle rigidity and expanding tension in the abdomen, clearly direct the examiner to the cause of the trouble.

With the gentlest palpation with the finger tips, and the constant pressure with the full, flat hand on the tense muscles, with the patient's cooperative attempt at muscle relaxation, there will be perceptible softening and relaxation of the muscle tone, the partial or even complete disappearance of pain and tenderness which is not the case when the epigastric symptoms are due to a ruptured viscus. There may be distention and the disappearance of liver dullness in both instances, however, this symptom has little value. A roentgenologic study will show escaped gas or fluid displacement if there is a perforation. Percussion and palpation, gently performed, are the best measures with which to diagnose the pain, muscle tension and skin and muscle tenderness whether the case is a perforated viscus or a cardiac case. The laboratory technic of whatever kind is of minor value in the presence of a suspected or an actual epigastric emergency whether medical or surgical. After the first few hours of diagnostic uncertainty, the progress of the disease usually becomes determinative one way or the other, it is in these stages that the diagnosis is so important.

The cases suffering from any lung disease have râles, rapid breathing, dullness in the lungs, limited breathing on the affected side, there is no muscle rigidity, no mass, no deep tenderness in the abdomen. There may be cutaneous hyperesthesia and hyperalgesia and marked muscle tension.

*Differential Diagnosis*—The problem is among three main generic pathologic conditions, *viz.* angina pectoris, coronary disease, and disease of the epigastric viscera. The first two are purely medical, the last one is purely surgical. The examiner is confronted with a definite emergency in any instance. There are other symptom complexes which may arise, but they are relatively unimportant.

It may be graphically represented in tabular form, which, however is not meant to be complete in every detail 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 (Table I)

TABLE I

DIFFERENTIAL DIAGNOSIS BETWEEN ANGINA PECTORIS, CORONARY AND EPIGASTRIC DISEASE

Angina Pectoris	Coronary Disease	Epigastric Disease
A perfectly still patient	Restless patient	Quiet patient
Symptoms of shock and collapse may be present	Shock is often present	Shock often present
Attacks come without effort	Without effort	Often after effort
No change in pulse rate, pressure rises	Fast pulse, low pressure	Little change in the early stages
Temperature normal	Fever may be present	Fever generally present, shortly after onset Temperature may be subnormal
Gastric symptoms rarely present	Gastric symptoms often present	Nausea and vomiting the rule
Blood picture normal	Blood picture often abnormal	Blood always abnormal
Before 50 yrs of age	After 50 yrs of age	Any age after youth
Pain in chest, cardiac region, retrosternal, substernal, in arms, neck, elsewhere Epigastrium in some cases	Pain comes suddenly, in same regions as in angina pectoris, epigastrium Fine râles may be present in bases of the lungs Never in right shoulder region	Pain comes suddenly, epigastrium first, diffuses downwards, may be in lower chest, often in right shoulder region Never in arms, upper chest
Epigastric muscle tension, never rigidity, no mass	Muscle tension—not muscle rigidity, relieved with opiates No mass Liver dulness never absent	Epigastric muscle tension, unrelieved by opiates in ordinary doses, mass often palpable Fluctuation often noted, liver dulness often absent
Hyperalgesia and hyperesthesia may be present	The same for coronary disease	Always present
Heart findings generally normal	Heart may show abnormal beats and sounds, friction rubs Later, definite changes	Nothing significant
Pain relieved by vasodilators	Not relieved	No effect
Patient improves under treatment	May improve, or get worse	Patient gets worse
Abdomen generally mobile	Abdomen mobile, often some tension, no rigidity	Abdomen immobile, often board-like
Medical emergency	Medical emergency	Surgical emergency

The diagnosis of epigastric surgical injuries demands immediate decision, the life or death of the patient may depend upon what is done within a few hours after the onset of pain Delay in making a diagnosis when the disease is above the diaphragm does not increase the risk or compromise the patient's welfare in any way

### CASE REPORTS

Case 1—A male, age 30, was admitted to the hospital and gave a history of having been seized with a sudden, severe, excruciating pain in the upper abdomen associated with

nausea, vomiting, *etc*, at six o'clock the previous evening. He was seen by a physician who gave morphine, something by the mouth and was told to take an enema. He suffered all night and came to the hospital about 9 A M the following morning. He was diagnosed as a case of coronary thrombosis. The patient rapidly got worse, consultation was called for and the diagnosis of a perforated viscus was made by the consultant. The advice was not followed until the patient got in extremis about 1 P M, when the abdomen was opened and a very large perforation of a duodenal ulcer was found. The patient died.

**Case 2**—A female, age 44, was taken suddenly ill with an excruciating pain in the epigastrium. The family physician gave her two half grain doses of morphine within two hours with very little relief. A surgeon was called to operate for a perforated epigastric viscus. The patient was very neurotic and had had four operations previously. The gallbladder had been removed for a similar attack. Subsequent studies showed that the heart gave the usual electrocardiographic findings of a small thrombosis of a branch of the coronary artery. Appropriate treatment relieved her condition.

**Case 3**—The patient was seized with a sudden, severe epigastric pain, associated with the usual clinical findings of an epigastric lesion. He was 65, and had been a chronic arteriitic case. A surgeon was called to operate for a perforated viscus. The patient died within 24 hours, having evidenced a typical picture of a coronary thrombosis.

To these reports may be added several cases of right sided pneumonia, which were diagnosed acute appendicitis, one of which was operated upon for appendicitis, another was diagnosed acute cholecystitis, but the surgical consultant found a pleurisy with effusion. Similar cases could be added to these. Two of which were rather tragic as laparotomies were performed when the condition proved to be a painful heart. Acute surgical diseases in the abdomen may coexist with painful heart diseases.

*Some Guideposts*—Every patient under 40 years of age presenting symptoms of an acute epigastric pathology should be examined for both lung and heart disease, but the chances are all in favor of acute disease of abdominal viscera, every patient over 50 presenting such symptoms should not be operated upon until the condition of the heart and lungs is ascertained.

It is noteworthy that males are more prone to the causative factors which produce coronary thrombosis and angina pectoris, and, also, that Africans, Asiatics and Mexicans are almost immune from such circulatory disturbances.

Jackson and Jackson<sup>23</sup> have advanced a theory of the causation of the pain in angina pectoris and coronary thrombosis. They report their experimental studies which appear to show that every symptom of pain, and its distribution, can be reproduced by electrical stimulation of the esophagus and, therefore, attribute all of the symptoms to esophageal lesions caused by stretching the muscles, lacerations and other injuries from vomiting, strains, spasms, *etc*. They attribute nothing to the pathology found in the heart or the great blood vessels.

**SUMMARY**—(1) The basis of the distribution of the symptoms of pain and tenderness observed in coronary thrombosis and angina pectoris and allied lesions is the embryologic development of the human organism.

(2) When descent of the heart and lungs into the adult position takes place, the embryologic nerve supply is carried along with the organs and is not segmental.

(3) Later, but also early in embryologic life, there is developed a counter-acting nervous system, the sympathetic, with its many ganglia and connecting fibers between the basal nerves and the sympathetic nerves, whose function is to correlate motor, sensory and functional impulses of these organs

(4) Later, also, as the body elongates, there is developed a cerebrospinal segmented nervous system, which, with its numerous connections between the basal and sympathetic systems through connecting fibers, innervates the body wall and the serous lining, pleura and pericardium, whose function is, through its motor and sensory nerves, protection of the vital organs and to herald the presence of disease, these warning signs are pain, tenderness and muscular rigidity

(5) There is an overlapping of these nerve fibers with consequent confusion of the symptoms largely because the basal nerves (parasympathetic) and the sympathetic nerves, through their ganglia, connect with the segmented cerebrospinal nerves which supply the body wall. There may be, also, true connecting fibers between these systems to the viscera which, under the stimulus of disease, may produce pain in the organs apart from the pain in the body wall, if true, such pain should be rhythmical and diffuse, which it is not, and separate from the sensations in the muscles

(6) Muscle tension and rigidity due to irritation of underlying serous covering, or lining, is marked even to board-like rigidity and is definite and segmented and increased pressure heightens the pain and tension, whereas, irritation of serous membranes elsewhere, as the pericardium and pleura in the diseases under discussion, does not produce in the abdominal muscles extremes of muscle rigidity and tenderness and rarely, if ever, deep tenderness

(7) A method of examination is described which should differentiate between muscle reaction and tenderness in cases of cardiac and pulmonary disease with symptoms referred to the epigastrium from acute surgical disease within the abdomen

#### REFERENCES

- <sup>1</sup> Hirschfelder, Arthur Douglass. The Diseases of the Heart and Aorta. J. B. Lippincott Company, 3d Edit., 382, 1918
- <sup>2</sup> Herrick, J. B. Clinical Features of Sudden Obstruction of the Coronary Arteries. J. A. M. A., 59, 2015, December 7, 1912
- <sup>3</sup> Osler, William. Angina Pectoris, Lushian Lectures. Lancet, 1, 697, March 12, 1910, 1, 839, March 26, 1910, 1, 973, April 9, 1910
- <sup>4</sup> Mackenzie, Sir James. Principles of Diagnosis and Treatment in Heart Affections. Henry Frowde, Oxford University Press, 3d Edit., 1917
- <sup>5</sup> Walton, A. J. The Surgical Dyspepsias. Edward Arnold & Company, 1923
- <sup>6</sup> Cope, Zachary. The Early Diagnosis of the Acute Abdomen. Oxford University Press, 7th Edit., 1935
- <sup>7</sup> Vaquez, Henri. Diseases of the Heart, 434. Translated George F. Laidlaw, W. B. Saunders Company, 1924
- <sup>8</sup> Cecil, Russell L. A Text-Book of Medicine by American Authors. W. B. Saunders Company, 1934
- <sup>9</sup> LeCount, E. R. Pathology of Angina Pectoris. J. A. M. A., 70, 974, April 6, 1918

- <sup>10</sup> Nachlas, I William Pseudo-angina Pectoris Originating in the Cervical Spine  
J A M A , 103, 323-325, 1934
- <sup>11</sup> Salzmann, Harry A Am Jour Med Sci , 188, 347, 1934
- <sup>12</sup> Keith, Sir Arthur Human Embryology and Morphology 5th Edit , 1933, William  
Wood and Company
- <sup>13</sup> Herrmann, George R Synopsis of Diseases of the Heart and Arteries The C V  
Mosby Company, 1936
- <sup>14</sup> Barker, Llewellys F Angina Pectoris and Coronary Thrombosis Med Clin N  
Amer , 18, 1507, May, 1935
- <sup>15</sup> Horne, Emmet F, and Weiss, Morris, M Southern Med Jour , 25, July, 1932
- <sup>16</sup> Riesman, David Myocardial Disease and Its Masquerades J A M A , 91, 1521, 1928
- <sup>17</sup> Jagic, M u Zimmermann Wiener klin Wchnschr , 48, 1430, 1935
- <sup>18</sup> Robey, William H The Differentiation Between Gallbladder Disease and Coronary  
Sclerosis in the Middle Ages Med Clin N Amer , 8, 1709, May, 1925
- <sup>19</sup> Patterson, Ross V Coronary Thrombosis with Special Reference to Its Differentiation  
from Abdominal Surgical Conditions Jour Med Soc N J , 1934
- <sup>20</sup> Morrison, Wayland A Coronary Disease, with Reference to the Acute Abdomen  
Western Jour Surg , Obst , and Gynec , 42, 309, 1934
- <sup>21</sup> Roberts, Steward R Diagnostic Relations between the Gallbladder and Heart Ill  
Med Jour , 56, November, 1929
- <sup>22</sup> Herrick, J B Thrombosis of the Coronary Arteries Ibid , 72, 387, February 8, 1919
- <sup>23</sup> Jackson, D E, and Jackson, Helen Experimental and Clinical Observations Regarding  
Angina Pectoris and Some Related Symptoms Jour Lab and Clin Med , 21, July,  
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## REGIONAL ILEITIS

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DIVISION OF MEDICINE

THE MAYO CLINIC, ROCHESTER, MINN

When Crohn<sup>1</sup> and his associates called attention to a granulomatous lesion of the terminal portion of the ileum, which they termed "regional ileitis," many of us recalled, from our own experience, isolated instances in which the features of the lesion conformed to this description. With greater care in history taking, improved roentgenologic technic, and surgical exploration, the number of cases of regional ileitis seen at The Mayo Clinic have rapidly increased. This may be partially accounted for by an increased incidence of the disease, but it is our conviction that greater alertness in recognizing the disease has been an important, if not the dominant, reason. It therefore seems that a review of our experience is worth while, even if it serves only to focus attention on this interesting problem.

There are two clinical types of regional enteritis. (1) The involvement of a rather short, localized segment, which usually consists of a single lesion, and (2) a similar process which involves longer segments and usually consists of multiple lesions. In addition to one or two short inflamed segments in the lower part of the ileum, we have included, in this category, involvement of similar segments which are situated in the upper part of the ileum and jejunum and which may be multiple or even involve many feet of the intestine (applying the term "regional enteritis"). Finally, the term may include involvement of one or more segments of the lower part of the ileum, which may spread to the cecum and ascending colon. The involvement may be either separate or continuous. Pathologically, both types differ grossly in extent, but microscopically both are associated with the same granulomatous process and tend to destroy all the intestinal walls, to cause stricture, and not uncommonly tend to cause adhesions to the adjacent bowel and produce fistulous formation.

Etiologically, there is as yet no final agreement. The first query always is "Are you sure it is not tuberculosis?" To the best of our knowledge, this particular lesion is not tuberculosis. Repeated sections have been stained for the tubercle bacillus and in several of our cases, as well as those reported by others, guinea-pigs have been inoculated but there has not been any evidence of tuberculosis. If there is any doubt, we have made it a rule not to include such a case in our study. Felsen,<sup>4</sup> reporting his work with the *Bacillus dysenteriae*, expressed the opinion that this organism is

the cause. The correlation of cultures of the stools, agglutinating properties of the blood serum, and tests for the presence of bacteriophage in the stools offer several problems that make it difficult to be sure that the question is settled. Felsen's clinical description of cases in which the blood serum had positive agglutinating properties is certainly suggestive. A segment of bowel which was resected at operation was submitted for bacteriologic study in four of our cases. In one instance cultures from the thickened wall of the bowel yielded a pleomorphic gram-positive *Streptococcus*. In the other three instances cultures were negative. A similar finding was reported by Minter,<sup>5</sup> who obtained an anaerobic *Streptococcus* from the peritoneal fluid, from a mesenteric lymph node, and from the deep surface of the intestinal ulceration.

Clinically, ulcerative colitis and regional enteritis are similar. In both, there is usually the history of early exacerbations and remissions. As time goes on, the disease becomes more continuous and more resistant to treatment. In both diseases the process may continue without remissions and one may encounter the small, short, narrowed colon (a small hose of 14 to 16 inches [35.4 to 40.6 cm] in length), or may find six to ten feet (182 to 300 cm) of greatly thickened, narrowed hose-like jejunum or ileum.

In our experience, we have seen both the acute and chronic stages of inflammation of the small bowel. We have records of several cases in which an exploratory laparotomy for acute appendicitis revealed a swollen, congested, and thickened condition of the terminal portion of the ileum and a regional adenopathy. In some cases the appendix was chronically inflamed, and in others it was acutely inflamed. Appendectomy was the only operation performed in these cases. What has happened to such patients? Those whom we have been able to trace have not had any further symptoms, but will they in the future? This group of cases of early acute enteritis is not included in this study.

In the study of chronic types of regional enteritis, we have selected only the cases in which lesions originated in the small intestine and were not associated with true ulcerative colitis or with primary granuloma of the cecum. Wherever there has been doubt as to the presence of intestinal tuberculosis, even though the positive evidence was very scanty, we have omitted such a case from this study. Likewise, we have not included that small but most interesting group of solitary ileal ulcers and ulcers of Meckel's diverticulum which we<sup>2</sup> reported previously.

As our report is not only a clinicosurgical study of such cases but is especially concerned with a "follow up" study of the patients, we are including those cases previously reported by one of us (P. W. B.<sup>1</sup>). Adhering to our rigid selection, this report comprises 39 cases observed at the clinic from 1922 to date. The presence of the lesion was established by operation or necropsy. Thirty-six patients were subjected to operation at the clinic and two were



# REGIONAL ILEITIS

operated upon elsewhere One patient died without being subjected to operation

*Clinical and Pathologic Features*—The ages of these patients ranged from nine to 61 years, one was ten years of age or less, three were between ten and 20 years, 11 were between 20 and 30 years, 14 were between 30 and 40 years, six were between 40 and 50 years, three were between 50 and 60 years, and one was 61 years of age This age distribution parallels that found in a series of cases of ulcerative colitis, in which 29 of the 39 patients were less than 40 years of age This probably is merely indicative that the

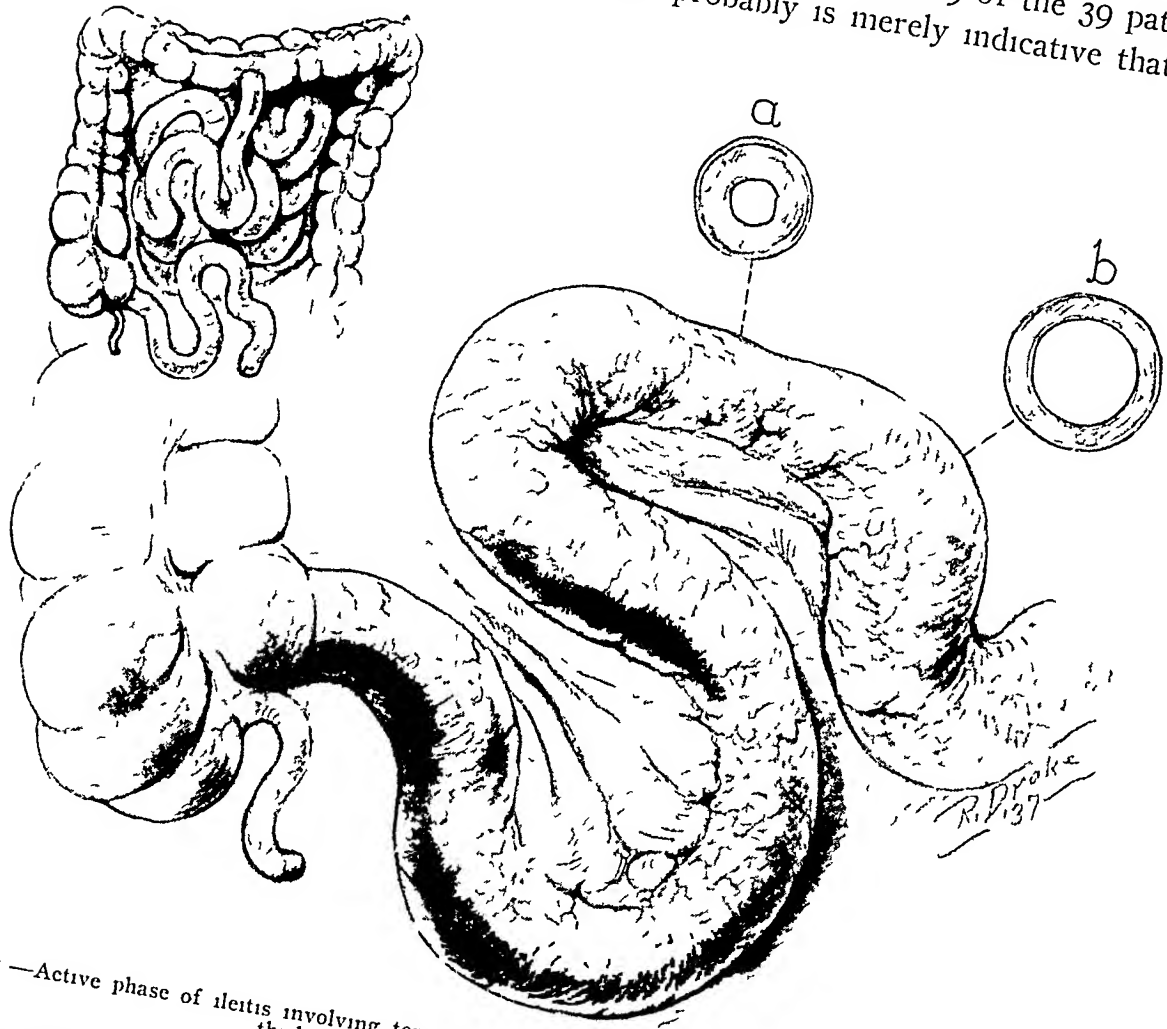


FIG 1—Active phase of ileitis involving terminal portion of the ileum, a and b represent the relative thickness of different segments of the ileum

more active lymphoid tissue of young people is an important predisposing factor in any inflammatory disease The sex factor was not significant in the cases of regional ileitis as 23 of the patients were males and 16 were females

*Situation of Lesion*—In the three cases in which the jejunum only was involved, the involvement was extensive The ileum was involved in 34 cases In 24 of these cases the involvement was in the lower or terminal portion of the ileum, in four cases it was in the upper part of the ileum, and in six cases it was in the terminal portion of the ileum and extended into the

cecum and ascending colon. Curiously enough, in these cases of ileocecal lesion, if the resection was carried out after a preliminary exclusion ileocolostomy, it was usually found that the disease was limited to the ileum and that the inflammation in the cecum had subsided. Finally, there were two cases of multiple involvement or "skip areas" throughout much of the small bowel. In these cases the narrowing was most marked in the lower part of the ileum.

Grossly the lesion consists of an inflammatory process which is rather sharply localized to a single segment of bowel but occasionally involves two or more segments that apparently are separated by intervening segments of normal bowel. In the more active phase the involved segment is greatly swollen, heavy, and reddened. It is commonly covered with plastic exudate and often is adherent to the bum of the pelvis and adjacent coils of intestines (Fig. 1). The mesentery attached to the diseased segment is stiff, enormously thickened, and contains enlarged hyperplastic lymph nodes. A slight amount of free turbid peritoneal fluid may be present. In the more chronic phase of the disease, which sometimes is seen at the primary operation and nearly always is seen when the abdomen is reopened following a previous short-circuiting anastomosis, the involved segment presents a different picture. At this stage marked edema, engorgement and exudate have to a large degree disappeared, but the intestinal wall still is greatly thickened. It feels leathery and in most instances is free of adhesions. Detailed pathologic study has failed to add to the original description of Crohn and his associates.

*Clinical Picture*—In a few instances the initial symptoms are abdominal pain and diarrhea which last only a few days and do not differ from the symptoms which occur in many cases of acute enteritis, so-called intestinal flu, and which are self-limited. In other cases there are recurring attacks of pain and diarrhea which are not especially severe. In many cases the onset is insidious and is heralded by obstruction which produces acute pain, nausea and vomiting, and abdominal distention. In these respects, the disease parallels chronic ulcerative colitis.

Pain, which is the outstanding feature of the disease, was present in 38 of the 39 cases. Strangely enough, the one exception was a case in which there was extensive jejunal thickening. The chief symptoms in this case were nausea, weakness, and loss of weight. Efforts to localize the lesion by the distribution of the pain are helpful in only one respect, that is, the pain is more likely to be situated below the umbilicus than above it.

In 20 cases the salient features were attacks of pain which were associated with nausea, vomiting, abdominal fulness, and borborygmus, that is, signs of obstruction. In the 13 cases in which the mechanical obstruction was less marked, pain and diarrhea were the chief symptoms. In eight cases, a previous operation had been followed by a fistula which had been associated with persistence of pain.

As would be expected, fever, which often was associated with chills, occurred in 21 cases and no doubt occurred in others. Oddly enough, leukocytosis of any degree (more than 10,000 per cubic millimeter) was not common, although it was present in one case in which complete obstruction had been present for three days. In this case the leukocyte count was 19,000 per cubic millimeter of blood, and an emergency ileostomy gave evidence of peritonitis. Death ensued on the eighth postoperative day. Secondary anemia (value for the hemoglobin was 12 Gm or less per 100 cc) occurred in 17 cases. The lowest value for the hemoglobin was 8.5 Gm per 100 cc. Anemia is not a prominent symptom and is related more to the duration of the disease and the deficiency of the diet than to actual loss of blood. This is contrary to what occurs in cases of ulcers of the ileum or ulcer of Meckel's diverticulum, in which hemorrhage is a common symptom. In one case in this series, tarry stools were associated with the attacks of pain and fever. The patient in this case was a boy, age nine, who had been ill four months. It is unusual that the boy has not had any symptoms since the ileocolostomy which was performed three years ago.

The patient who has regional ileitis may be of either sex and of any age, but usually is less than 40 years of age. The pain is most frequently situated in the lower half of the abdomen. The attacks usually have existed from four months to 20 years when the patient first seeks medical advice, the average duration being about four years. In this series of cases nausea and vomiting frequently were associated with the attack and in many instances they had led to an unsuccessful operation. Often, the real pathologic lesion had not been identified or an unfavorable prognosis of an inoperable malignancy or tuberculosis had been given. If the obstruction is not severe, diarrhea is a common accompaniment of the attacks of pain. There are no significant changes in the blood, although a macrocytosis is noted in some cases, but this can be considered only a suggestive sign.

The physical and laboratory data offer little help in the diagnosis. A tender mass, caused by an adherent inflamed loop of the terminal portion of the ileum, may be palpated, but this also is only suggestive. In the presence of any acute obstructing episode, the usual signs of obstruction would be observed. Abdominal fistulae are suggestive but not diagnostic until other data are at hand.

We are not the first to point out that a typical, pathognomonic clinical syndrome of regional enteritis has not been elaborated, that, in fact, the clinical diagnosis remains conjectural or tentative until roentgenologic evidence of the disease is adduced. Weber<sup>1</sup> comments on the roentgenologic diagnosis of regional enteritis as follows: "It may be assumed that the competently performed roentgenologic examination of the small intestine can be made to deliver diagnostic evidence of the disease at least as early as symptom-producing and sign-producing morphologic changes develop. Such evidence is almost entirely anatomic in character, reflecting not only the site, but also

the kind, intensity and extent of the pathologic changes. The early, relatively unpronounced degree of submucosal infiltration may be manifest roentgenologically only by flattening of the normally high mucosal relief pattern, if ulceration has taken place, the relief pattern is irregular and jagged, not smooth and flat. In more advanced stages of the disease the affected segment of intestine is shortened, its lumen is narrowed, and it loses its mobility and pliability,—all roentgenologically elicitable expressions of the productive inflammatory reaction of the disease. Associated with these anatomic changes are a relative hypermotility of the affected portion of the bowel and a relative hypomotility of the unaffected portions above and below it. That the serosal aspect of an affected loop of intestine may show little palpable or visible evidence of pathologic change was forcibly brought to our attention in a case in which the diagnosis of regional ileitis was made roentgenologically. Operation was not performed. The pathologist performing the necropsy found so little evidence of disease, from his examination of the serosal aspect of the small intestine, that he was inclined to view the roentgenologic diagnosis somewhat skeptically. Only after the intestinal wall and the mucosal surface were more intimately examined were the characteristic pathologic changes apparent.

*Previous Operations*—The startling fact that 26 of these 39 patients had undergone one and often more unsuccessful operations for this disease is evidence of its seriousness, as is the fact that in the past the disease has remained unrecognized even after the abdomen has been opened. Sixteen patients in this series had undergone an appendectomy which had failed to relieve their symptoms. Eight patients had fecal fistula which had followed previous operations, such as drainage of an abscess, or an effort to relieve obstruction in the terminal portion of the ileum by freeing the intestinal loops. In one case the fistula had developed after the ileum had been anastomosed to the ascending colon. A diagnosis of tuberculosis was made in a case in which the patient was subjected to a right salpingo-oophorectomy after an appendectomy had been performed previously. In two other cases in which an exploratory laparotomy had been performed, the surgeon had made a diagnosis of tuberculosis and had closed the abdomen. The symptoms had recurred in four cases in which resection of the ileum or colon had been performed. Two patients who had been subjected to appendectomy had been told that they had a disease of the ileum but they had not been advised about the proper treatment. A boy who had undergone an appendectomy had been told that he had a disease of the ileum. One year after the appendectomy had been performed, the boy had undergone an exploratory laparotomy. A diagnosis of lymphosarcoma had been made but no attempt had been made to remove the tumor. A fistula had developed in a case in which appendectomy and drainage had been performed for either "cancer or actinomycosis."

*Treatment*—The treatment of regional ileitis is essentially surgical and usually necessitates removal of the diseased segment with reestablishment of

the continuity of the intestinal tract. The operation may be performed in one or two stages. In a large proportion of the cases the disease is complicated by obstruction, by acute or subacute inflammatory changes, or by the presence of abscesses or intestinal fistulae when the patients are seen by a surgeon. It therefore is our belief that for reasons of safety the employment of the two stage procedure should be the rule rather than the exception. In cases in which the terminal portion of the ileum is involved, with or without extension into the cecum, it has been our practice to perform, as the first stage

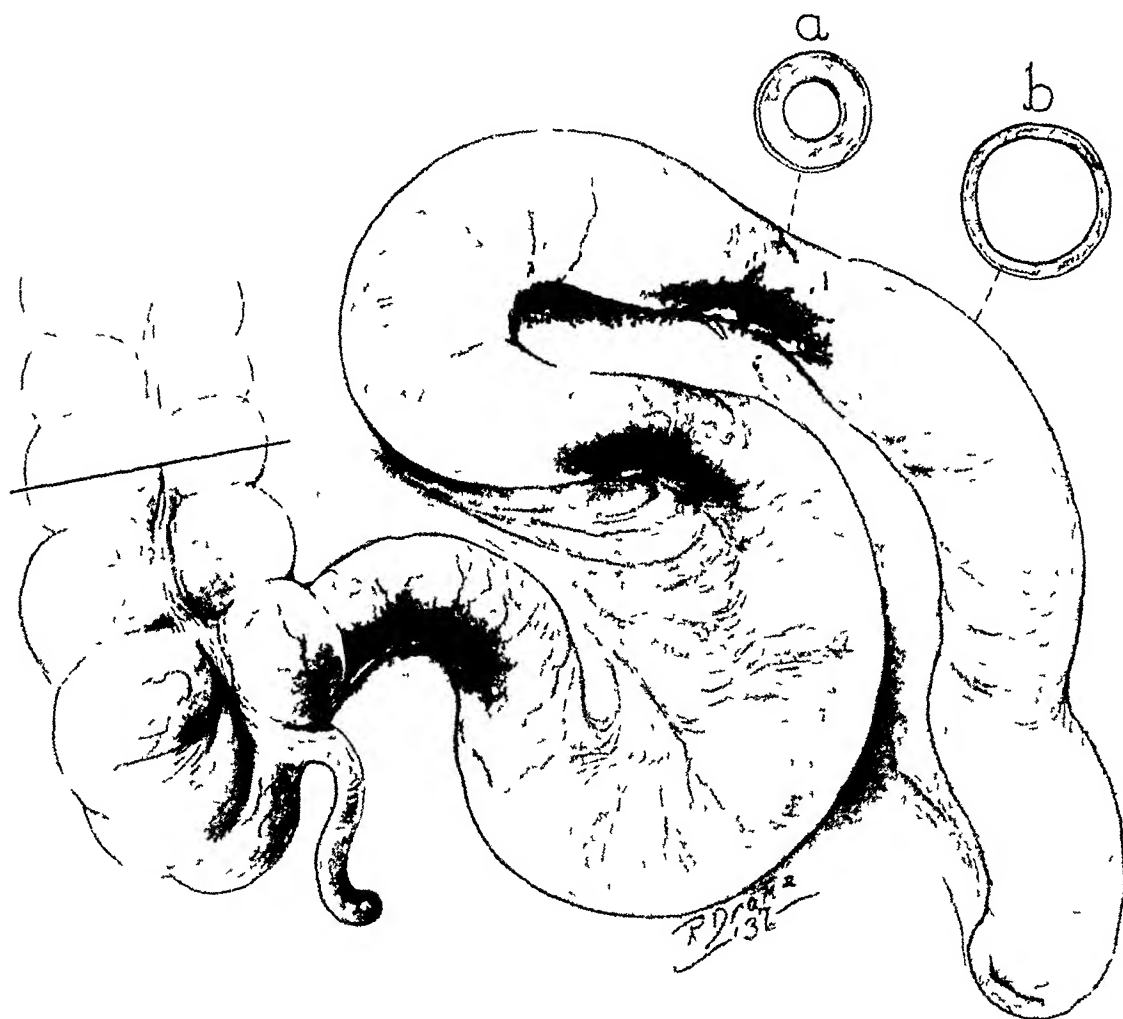


FIG 2—Subsidence of the inflammatory reaction, *a* and *b* represent the relative thickness of different segments of the ileum

procedure, an ileocolostomy. A loop of ileum proximal to the lesion is united to the right half of the transverse colon, preferably as an end-to-side anastomosis. Since the principal purpose of this procedure is to exclude the diseased segment from the irritating effect of the intestinal current so as to permit partial subsidence of the inflammatory process (Fig 2), it follows that a side-to-side ileocolostomy without division of the ileum distal to the anastomosis will not fully accomplish this purpose.

The value of an end-to-side ileocolostomy with complete diversion of the fecal stream, which permits subsidence of the inflammatory reaction in the

region of a fecal fistula and thus facilitates the subsequent resection, is illustrated by the following case

**Case Report**—A male, age 20, had an inflammatory lesion which involved the ileocecal segment. The lesion was complicated by a fecal fistula. Operation revealed that the mass was markedly fixed and surrounded by dense adhesions. A side-to-side anastomosis between the ileum and transverse colon was considered the safest procedure. Following this operation there was some improvement in the patient's health and some diminution in the amount of drainage from the fistulous tract. Two months later, resection was advised, but at operation the mass was still markedly fixed and the risk of resection was considered high. The ileum distal to the anastomosis was divided, thus completely excluding the ileocecal segment from the fecal current. There was almost complete cessation of fecal drainage, and the health of the patient improved markedly. At the time of resection, approximately five years later, the mass was quite free and the resection was readily done with minimal risk.

Although six of the eight patients who were subjected only to the first stage of the procedure (ileocolostomy) for localized enteritis reported that they were well and free of symptoms two to five years after operation, we believe that resection of the involved portion of the bowel is indicated in all cases in order to prevent the spread of the infection. In one case in which the patient delayed returning for the second stage (resection) for four years, a recurrence of the process was discovered in a short localized segment of ileum at the site of the previous end-to-side ileocolostomy.

We think that the interval between the stages of the procedure should be varied, depending chiefly on the general condition of the patient and the nature of the complicating lesion. In cases of localized ileitis which is not complicated by the formation of an abscess or fistula and in which the general condition of the patient is good, resection can be safely undertaken within three to four weeks after the initial procedure. In the cases in which the disease is associated with an enormously thickened mesentery and in cases in which a fistula or an abscess has formed, there is a definite advantage in permitting two to four or even six months to intervene between the stages in order to permit partial resolution of the inflammatory process. In no instance have we seen any progress of the disease occur between the first and second stages when the interval did not exceed six months, but on the contrary there has been without exception a very marked subsidence of the inflammatory process which greatly facilitates resection.

Surgical treatment was employed in 36 cases. The operative procedure and the results are shown in Tables I, II, and III.

Table I reveals that extensive regional enteritis of the small intestine is a serious condition and indicates that not much can be expected unless resection of the involved intestine is possible. In the two cases in which 70 cm of the ileum were resected, the patients have remained well for one year, and for eight months, respectively. In the cases in which only short-circuiting procedures were possible, one patient is fairly well four years later, and the other three are little, if any, better. One patient died following an emergency ileostomy and two others died at home, months after the operation.

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TABLE I  
EXTENSIVE REGIONAL ENTERITIS

Patient	Site of Lesion (as Shown by Operation)	Surgical Procedure	Results
1	Entire jejunum	Exploration only	Died 7 months later
2	Upper portion of jejunum	Exploration only	Died 6 months later
3	200 cm of jejunum	Gastrojejunostomy	Fairly well 4 years later
4	70 cm of upper portion of ileum	Resection and anastomosis	Well 1 year later
5	Segment throughout small bowel (marked obstruction in lower portion of ileum)	Ileotransversostomy (partial exclusion operation)	Not well 22 months later
6	2 segments of midileum (acute obstruction)	Emergency ileostomy (general peritonitis present)	Died 8 days later
7	8 or 9 segments in lower portion of ileum (with obstruction)	Ileotransversostomy (partial exclusion operation)	Fair health 2 years later (associated pernicious anemia)
8	Multiple segments in lower portion of ileum, involving about 150 cm	Ileotransversostomy (partial exclusion operation)*	Not well 7 months later
9	3 segments in lower portion of ileum	Resection of 70 cm of lower portion of ileum and ileotransversostomy	Well 8 months later

SUMMARY OF RESULTS

Patients	Condition	Time after Operation
2	Well	(1 year) (8 months)
1	Fairly well	(4 years)
3	Not well	(2 years) (7 months) (2 years)
3	Dead	

\* Resection later of terminal 150 cm of ileum (December 2, 1936)

TABLE II  
LOCALIZED REGIONAL ENTERITIS

Patients	Surgical Procedure	Results			
		Well	Not Well	Dead	No Data
1	Ileo-ileostomy	1			
5	Ileocolostomy	3	2		
2	Ileosigmoidostomy	1		1	
1	Closure of fistula and drainage			1	
2	Resection of lower portion of ileum and anastomosis	2			
5	Resection of lower portion of ileum and right colon with ileocolostomy (one stage)	2	2	1	
10	Ileocolostomy and later resection	9			1
1	Ileosigmoidostomy and later resection of lower portion of ileum	1			

In the 27 cases in which the process was localized in the lower part of the ileum (Tables II and III), results are more encouraging. In these 27 cases, we have further data on all but one patient. Nineteen patients are well, four are still having trouble, and three have died. In eight of the 27 cases, the short-circuiting operation was the only operative procedure employed. One of the patients has remained well for two years, one, for two and one-half years, and four, for from five up to six and two-thirds years with little, if any, further trouble. In one case in which drainage and an attempt at closure of a fistula were the operative procedures, the patient died at home, months later, of pulmonary complications. In 18 of the 27 cases, the diseased segment was resected. In four of these cases, the patients waited for one to five years before undergoing resection. The remaining 14 of the 18 patients underwent either a primary resection or the second stage of the procedure within two to four months after the initial operation. Of these 18 patients who had resection, two have continued to have further trouble characterized by persistence of fecal fistulae. One died following a one stage resection, and no recent data are available for one other patient. The remaining 14 patients are well. Eight of these patients have lived one year or less, one has lived for three years, and five have lived from four to 14 years since the operation. The last patient, who has now been in excellent health for more than 14 years since the resection, demonstrates that these patients should recover if the diseased segment is completely removed.

TABLE III  
LOCALIZED REGIONAL ENTERITIS SUMMARY

Surgical Procedure	Total Patients	Well	Results Not Well	Dead	No Data
Short-circuiting operation only	8	6 (1 for 2 yrs, 1 for 2½ yrs, 4 for 5 yrs plus)	1 (same symptoms)	1 (2 mos later at home)	
Resection of diseased segment	18	14 (8 for 1 yr or less, 1 for 3 yrs, 5 for 4 to 14 yrs)	2 (fistula persists)	1 (6 days later)	1
Drainage and attempted closure	1			1 (8 mos later at home)	

Data, therefore, are available in 35 of the 36 cases in which operation was performed. Twenty-two patients are apparently well, one is in fair health, and six are not well. Two deaths occurred in the hospital and four patients died after they returned home. The immediate surgical mortality was 5.5 per cent (two deaths). In these 36 cases, 47 major surgical procedures were carried out with a mortality of 4.2 per cent.

In three cases in which only a short-circuiting operation was performed, a deficiency syndrome with the hematologic picture of primary anemia has developed. It is impossible to say whether or not this syndrome is related



to the ileitis. All are being controlled by liver. In another case, a deficiency disturbance, comparable to the wet type of beriberi, developed after the operation. This disturbance cleared up promptly as a result of a normal diet, plus vitamin B.

#### SUMMARY

We have made a clinical study of 39 cases of regional enteritis and the surgical treatment and end-results in the 36 cases in which the patients were operated upon at the clinic.

#### REFERENCES

- <sup>1</sup> Brown, P. W., Barger, J. A., and Weber, H. M. Chronic Inflammatory Lesions of the Small Intestine (Regional Enteritis). *Am J our Digest Dis and Nutrition*, 1, 426-431, September, 1934.
- <sup>2</sup> Brown, P. W., and Pemberton, J. deJ. Solitary Ulcer of the Ileum and Ulcer of Meckel's Diverticulum. *Ann Int Med*, 9, 1684-1702, June, 1936.
- <sup>3</sup> Crohn, B. B., Ginzburg, Leon, and Oppenheimer, G. D. Regional Ileitis, a Pathologic Clinical Entity. *J A M A*, 99, 1323-1328, October 15, 1932.
- <sup>4</sup> Felsen, Joseph. The Relationship of Bacillary Dysentery to Distal Ileitis, Chronic Ulcerative Colitis and Non-specific Intestinal Granuloma. *Ann Int Med*, 10, 645-669, November, 1936.
- <sup>5</sup> Mixer, C. G. Regional ileitis. *ANNALS OF SURGERY*, 102, 674-689, October, 1935.

DISCUSSION—DR REGINALD H. JACKSON (Madison, Wis.)—<sup>2</sup>I was greatly interested on Doctor Pemberton's timely paper on regional ileitis. Many surgeons have not, as yet, seen or recognized an instance of this distinct clinical entity. I should like to report three interesting cases of this condition which have come under my observation and which have presented some unusual features.

Case 1—A girl, age 16, who, six months previous to admission, had had an appendectomy performed elsewhere. Convalescence was unsatisfactory, the patient continuing to have intermittent attacks of acute abdominal cramps with tenderness in the right lower quadrant accompanied by nausea, vomiting, diarrhea and a rise of temperature to 101° F. The surgeon reported that at the operation he encountered a nest of adherent coils of intestine, and in digging out the appendix, opened a small, creamy abscess in the meso-appendix. The drainage had persisted for several weeks and the patient had developed a marked anemia and increasing lassitude. At operation the involved segment of the ileum and cecum was resected (Figs 1, 2 and 3).

Such a history should immediately excite our suspicion of a terminal ileitis. As Doctor Pemberton emphasized, the actual diagnosis rests with the roentgenologist.

Whatever the etiologic agent is which is active in this disease, it would seem to be subject to recurrent periods of quiescence and activity covering many years, in some instances. This is brought out quite decidedly in the next case.

Case 2—A female, age 30, who, in 1909, was operated upon for what was thought to be an interval appendix, having had, four weeks previously, an attack of acute abdominal cramps with vomiting, diarrhea and elevation of temperature to 101° F, at



FIG 1—(Case 1) A telephotograph made during operation showing the typical thickening of the bowel wall of the terminal 18 inches of ileum and the enlarged lymph nodes in the mesentery, characteristic of this lesion



FIG 2—(Case 1) Photograph of the specimen immediately after removal



FIG 3—(Case 1) Roentgenogram of specimen removed after it had been filled with barium. The so called "string sign" is distinctly shown

which time she was decidedly tender in the right lower quadrant. Exploration revealed some free serous fluid in the right lower quadrant, the terminal 18 inches of ileum enlarged, thickened, doughy and anemic—resembling a dead, water soaked night crawler

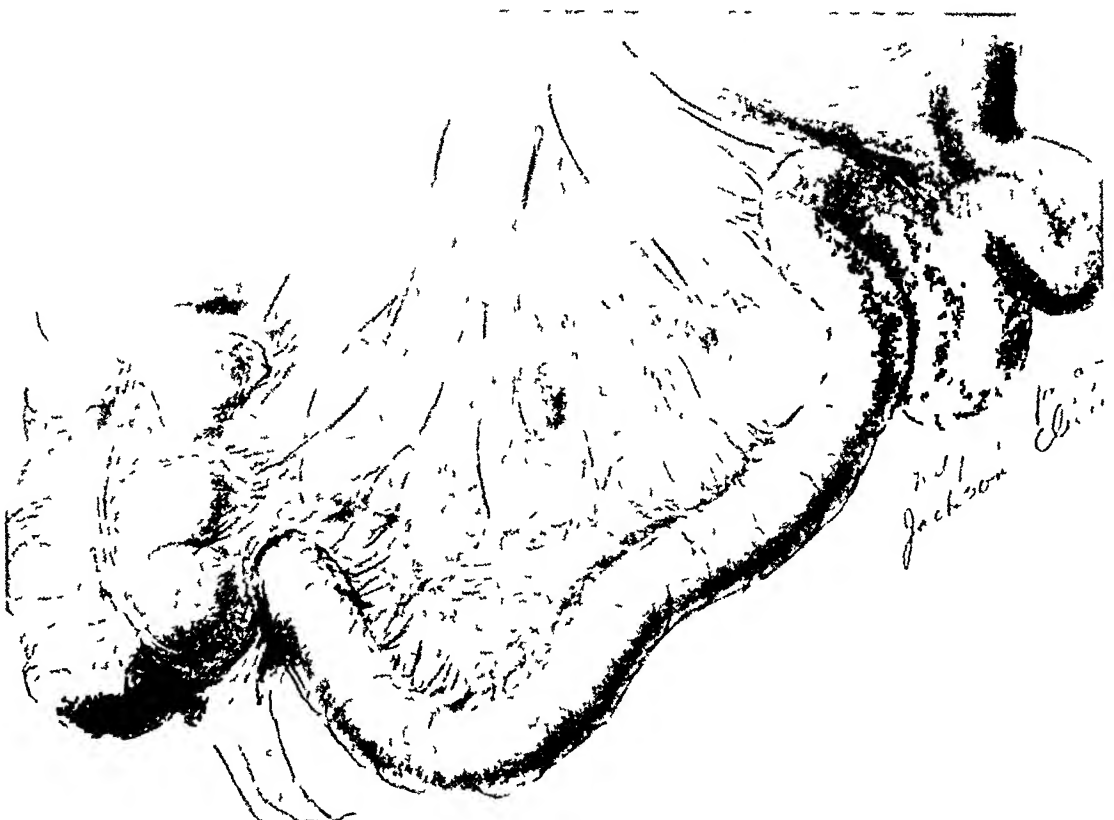


FIG 4—(Case 2) Drawing showing the gross appearance of the pathology found at operation in 1909

The attached mesentery had a dusky semithrombotic appearance and contained enlarged lymph nodes. The appendix was of the noncommittal type (Fig 4). In view of the limited segment of the bowel involved and its appearance of favorable viability, resection

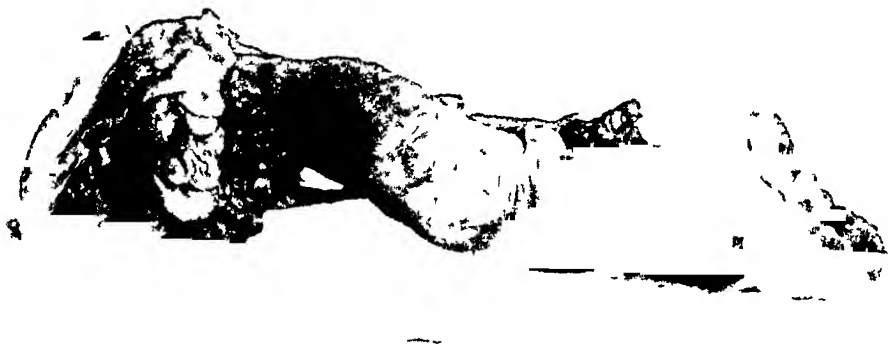


FIG 5—(Case 2). Photograph of the fresh specimen of the segment of ileum removed in 1929. In its fresh state it still retained a hose-like rigidity per se.

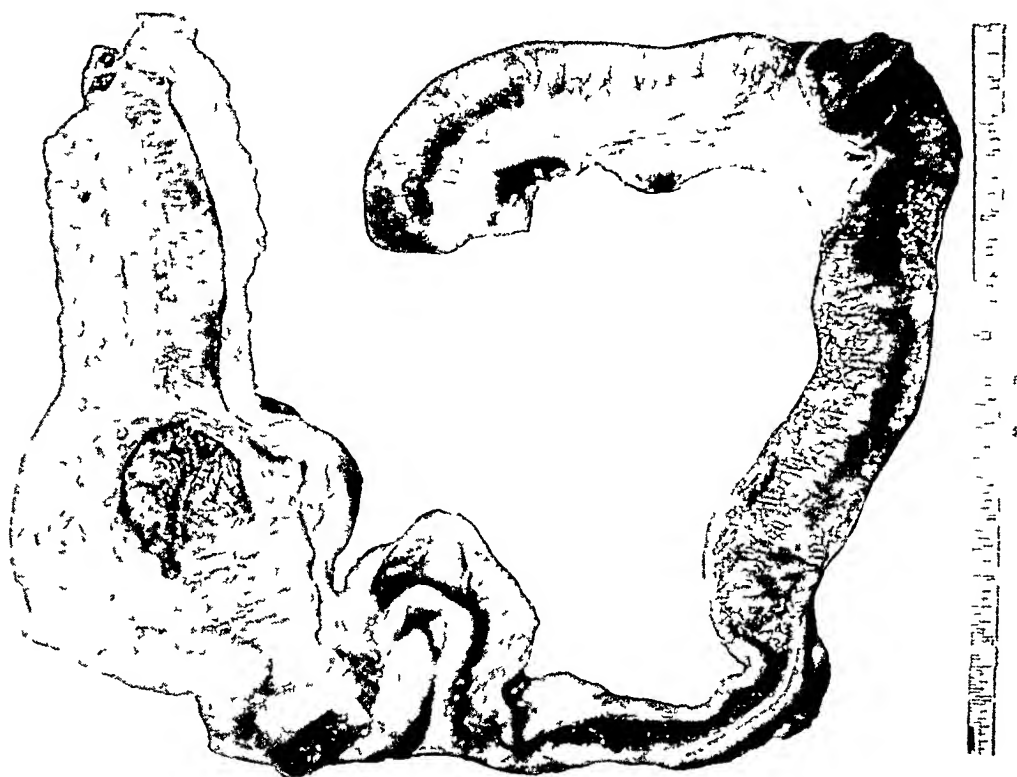


FIG 6—(Case 2). Photograph of the specimen removed January 2, 1935. It consists of the terminal 28 inches of ileum, the cecum and part of the ascending colon and exhibits the same hose-like rigidity in the fresh state as that noted in the previous specimen of ileum removed in 1929 (Fig 5).

was not thought advisable, an appendicectomy was performed and the wound closed. I now believe that this was an early stage of a terminal ileitis.

For the next 12 years she was seen occasionally, and complained that she suffered intermittently from acute abdominal cramps, vomiting, diarrhea and pain in the right lower quadrant accompanied by a slight fever and malaise.

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In 1922, the attacks became severe enough to require hypodermics of morphine. At this time a thorough clinical examination of the gastro-intestinal, biliary and urogenital systems was made with negative results.

From 1922 to 1929 she was fairly free from distressing attacks. Then they gradually increased in severity. Visible peristalsis was noted and a diagnosis of chronic intermittent intestinal obstruction was made and exploration advised.

At operation, in 1929, the involved terminal ileum, was resected (Fig 5), after which the patient's general condition improved decidedly and she was free from symptoms until October, 1934, when the same cramping pain began to recur. At this time roentgenologic examination revealed a greatly diminished lumen of the terminal ileum which has been designated Kantor's "string sign."



FIG 7—(Case 3) Drawing of gross pathology found at operation in the segment of upper jejunum which resembled very closely that evidenced in the terminal ileum in Cases 1 and 2

She was reoperated upon, January 2, 1935, and a practically exact reproduction of the condition found at the previous operation was revealed. There was no obstruction whatsoever at the point of the previous anastomosis nor did the disease invade the wall of the cecum (Fig 6).

Professor Bunting noted that "The lesion is like that of five years ago and is to me unique. There is a subacute or chronic inflammation involving mucosa, submucosa, muscular layer and subperitoneal tissues, many lymphoid and mononuclear cells and also fibroblasts, but strikingly many eosinophiles."

The patient has remained free from symptoms so far. This may not be a case of specific terminal ileitis under Crohn's definition, but it has been most interesting to follow its long course.

**Case 3**—A male, age 57, who for several months had suffered from intermittent attacks of abdominal cramps accompanied by nausea, vomiting, slight fever to  $101^{\circ}$  F, and alternating spells of diarrhea and constipation, marked loss of weight, strength and a secondary anemia

At operation pathology was found involving the proximal jejunum, practically duplicating that noted in the terminal ileum in Cases 1 and 2 (Fig 7) The diseased segment of the jejunum was resected Gross examination of the specimen showed the same type of thickening of the bowel wall as was noted in the previous cases with no definite point of obstruction, the disease progressing in the same tapering fashion as noted in Case 2

The enlarged lymph nodes in these two cases suggests to me that the etiologic factor in some cases may be a fungus organism similar to *Streptothrix* Professor Bunting has found spores in one instance but has, so far, not been able to develop cultures

While I have some 15 records of resection of the cecal region for so called hyperplastic tuberculosis during the past 30 years, they seem to me, as I recall them, not to conform in the pathologic aspect or clinical course to this regional ileitis type first described by Crohn

# ENTERITIS OF THE OBSTRUCTED LOOP FOLLOWING ENTERO-ANASTOMOSIS FOR INTESTINAL OBSTRUCTION

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BETHLEHEM, PA

WHEN an intestinal obstruction is found to be due to a mass of adhesions involving the small intestine with no evidence of gangrene or strangulation, the operation of choice is often felt to be the establishment of an anastomosis around the obstructed and adherent coils. If the obstruction in the adherent loops persists, Holm and the author,<sup>2</sup> reported, in 1932, in both clinical cases and the experimental animal, that an ulcerative enteritis of these loops develops which is accompanied by a definite syndrome of diarrhea, vomiting, intermittent abdominal cramps, overactive peristalsis, loud borborygmus and dilatation of the involved intestine, which can be relieved only by complete resection of the entire side-tracked area. As our former report was based upon only two clinical cases and as in the last three years we have had three additional instances, it seemed of interest to review these cases in detail and to describe certain further observations that have been made in connection with this syndrome.

## CASE REPORTS

**Case 1**—Male, age 16. Admitted November 18, 1928, with symptoms and signs of acute intestinal obstruction of two days' duration. At operation several loops of the terminal ileum were found matted together and adherent to the lateral wall of the pelvis, around a gangrenous Meckel's diverticulum, causing a complete intestinal obstruction. The involved loops of ileum with the Meckel's diverticulum were resected, following which a lateral anastomosis was performed between the ascending colon and the ileum, four inches proximal to the resection. The four-inch blind limb of ileum distal to the anastomosis was placed over the large defect in the posterior parietal peritoneum of the pelvis where the intestinal coils had been adherent. Ten days after the operation the patient became slightly distended, and began having mild attacks of visible peristalsis in the lower abdomen which recurred during the remainder of his stay in the hospital. His general condition was good. After his discharge, December 7, 1928, the attacks of visible peristalsis recurred with increasing frequency and were associated with marked borborygmus and pain. He had from two to six loose bowel movements daily, the pain being relieved shortly before defecation. His symptoms becoming progressively worse, he was readmitted January 26, 1929, and was operated upon two days later. The four inches of blind ileum distal to the anastomosis, performed the previous November, had become greatly elongated and distended, and filled the lower half of the abdominal cavity, and was coiled upon itself, with dense adhesions to the cecum and pelvic wall. The blind end of the ileum was partially freed from adhesions when the patient's general condition became too serious to permit resection, and the operation was hastily terminated by performing a lateral ileo-ileostomy between a point near the end of the blind limb and an area immediately proximal to the former ileocolostomy. Recovery was prompt, and the patient was discharged February 9, 1929. Examination, September 21, 1929, showed the patient to be much underweight, due to a severe diarrhea of four months' duration. There had been occasional attacks of distention, borborygmus, and painful peristalsis. He was placed on a strict diet and by January 2, 1930, was greatly improved although abdominal distention and a mild diarrhea had persisted. His appetite had been good throughout.

The patient was readmitted January 7, 1930, during an aggravation of the abdominal symptoms, and he was operated upon three days later. The lower two-thirds of the abdominal cavity were filled with the hugely elongated and dilated blind loop of terminal ileum, which was fully 18 inches in length and three to four inches in diameter and showed marked ulceration throughout. The mesenteric lymph nodes were all markedly enlarged. Proximal to the ileocolostomy the ileum seemed normal. The blind loop of ileum was freed of adhesions and resected and the sigmoid sutured over the denuded areas. Microscopic examination of the resected intestine showed a massive infiltration of small round cells into the mucosa and submucosa with some areas of destruction of the epithelial lining. This infiltration extended into the muscularis. There were secondary inflammatory changes with infiltration of fibrous tissue into the submucosa and muscularis. This was evidently a chronic inflammatory process that was still active in spite of the attempts at healing. The patient was discharged January 28, greatly improved, although he still had a mild diarrhea. The diarrhea persisted for several weeks after his return home. Fifteen months later, he was in excellent health, had gained 35 pounds in weight and had no gastro-intestinal complaint. He has remained well six years.

*Summary*—A boy of 16, after resection of the terminal ileum for intestinal obstruction due to a Meckel's diverticulum, and lateral ileocolostomy, with a short loop of blind ileum left distal to the anastomosis, developed a severe enterocolitis with low abdominal distention, pain, and borborygmus, and was only slightly relieved until a complete resection of the blind loop was finally performed, the loop having become hugely elongated, distended, and ulcerated, filling almost one-third of the abdomen. He has remained well. This case has been cited because it presents a clinical picture quite similar to those following, due to the ulceration and dilatation of the short blind end of ileum—beyond the anastomosis—which had been allowed to remain, as it was feared that postoperative adhesions of the small intestine might again produce obstruction. It was deliberately planned to use this blind end to cover over the raw area and to meet any complications that might result later from this procedure.

**Case 2**—Male, age 12. Admitted June 11, 1929. Three days before admission, the patient was seized with acute appendicitis, and at operation one hour after admission a gangrenous, perforated appendix was found within a large abscess walled off by intestinal coils. Appendicectomy was performed and the abscess drained. Convalescence was prolonged because of wound infection, but otherwise was uneventful. At a follow up examination October 17, 1929, the patient was in excellent health. He remained free from abdominal symptoms until April 5, 1930, when intestinal obstruction occurred. At operation, the terminal three feet of ileum were found adherent to themselves, to the cecum, and to the anterior abdominal wall. Adhesions were divided to release a three inch loop of strangulated but viable ileum. Inasmuch as extensive, dense adhesions threatened future strangulation a lateral anastomosis was established between the transverse colon and the ileum at a point proximal to the adhesions. Throughout his convalescence the patient had a good appetite and his general condition was excellent. A mild, painless diarrhea, with considerable borborygmus and moderate distention of the lower abdomen, developed one week before his discharge on April 22, continued in a mild form until May 4, when the diarrhea became severe and painful, and vomiting occurred. These symptoms became progressively worse, and on readmission, May 9, the patient was undernourished, dehydrated, drowsy, and very toxic. The abdomen was moderately distended and generally tender, but there was neither rigidity nor palpable mass. At operation the following morning, the terminal three feet of ileum, side-tracked on April 7, were found elongated to seven feet, greatly dilated, acutely inflamed and ulcerated,



with the distal one foot completely obstructed in a mass of adhesions. The meso-ileum contained many lymph nodes varying in size from that of a pea to a walnut. The colon was collapsed proximal and distal to the anastomosis. The side-tracked loop was resected from the anastomosis to the cecum. During the manipulations of resection, several ulcerations of the loop perforated. The abdominal cavity was drained. A serious wound infection and the preoperative debility prolonged the convalescence. A mild diarrhea persisted throughout the patient's stay in the hospital and continued for several months after his discharge. Recuperation was slow for several months following his return home, but at the follow up examination one year later, May, 1931, he had gained 25 pounds in weight and his general health was excellent. He still is quite well, five years later.

*Summary*—A boy, age 12, nine months after an appendectomy and drainage of an appendiceal abscess, developed an intestinal obstruction due to massive postoperative adhesions of the ileum which was relieved by an ileocolostomy around the obstructing coils. Postoperative diarrhea supervened with low abdominal pain, distension and borborygmus which failed to respond to treatment. One month later reoperation became necessary. The terminal side-tracked ileum was found to be a hugely distended mass of adherent intestinal coils, ulcerated, acutely inflamed, and obstructed. Following resection of this ulcerated and obstructed mass, the patient made a slow but satisfactory recovery and has remained well ever since.

*Case 3*—A woman, age 45, was admitted July 6, 1934. She had had, in 1914, a bilateral oophorosalphingectomy and appendectomy, tonsillectomy, in 1920, hemorrhoidectomy, in 1922, and an operation for acute intestinal obstruction, in 1925, with release of omental adhesions. In 1930, there was again acute obstruction of the ileum due to a mass of adhesions of the ileum, sigmoid, omentum and transverse colon, and an ileocolostomy was performed, from a point above the obstruction to the middle of the ascending colon. Recovery uneventful. Wassermann four plus.

Following this operation at intervals of three to four months, the patient had peculiar attacks of severe generalized abdominal pain with diarrhea followed by the expulsion of a very large mass of loose feces. Between attacks, cathartics were required. Some relief was obtained by colonic irrigations. On admission, the left lower quadrant of the abdomen was prominent and distended, and gurgling peristalsis was audible without a stethoscope (borborygmus).

At operation the terminal ileum was found to be involved in a mass of firm adhesions and was matted together with the omentum, cecum, sigmoid, and adherent to the abdominal wall. The former anastomosis was found to be from the middle of the ileum to the ascending colon. There was no complete obstruction found in the side-tracked loop but numerous constricted areas and an occasional small superficial ulcer were noted. The regional mesenteric lymph nodes were enlarged. The adhesions involving this loop were separated, and it was resected down to the ileocecal valve. Convalescence was uneventful except for a postoperative diarrhea that subsided within a week.

*Follow Up Report*—Two years and four months after the operation, patient had had no further attacks of diarrhea, and constipation was relieved. She still had headache and backache, probably due to lues.

*Summary*—A woman, age 45, who, following an ileocolostomy for intestinal obstruction due to a mass of adhesions involving the terminal ileum, developed attacks of generalized abdominal pain, diarrhea and borborygmus. She was, apparently, completely cured by a resection of the side-tracked ileum, which showed persistent constrictions due to the adhesions, no complete obstruction but a mild ulcerative enteritis.

**Case 4**—A man, age 29, was admitted, June 9, 1932, with symptoms of acute intestinal obstruction. In 1915, appendicectomy had been performed elsewhere. In 1928, an acute intestinal obstruction had been relieved by simple release of adhesions. One year and six months later, he had symptoms of obstruction with spontaneous recovery. Operation revealed a mass of dense adhesions that seemed to involve almost the entire ileum. A few obstructing adhesions were released and an ileocolostomy performed from a point proximal to the adhesions to the middle of the transverse colon. Convalescence uneventful. He was discharged in two weeks, having no further pain, but averaging four loose stools a day. This diarrhea never ceased. Five months after discharge he began to have gurgling sounds over the right lower abdomen and he could feel gas or fluid passing a point in that region accompanied by a sharp pain, these sensations were aggravated by eating or drinking. He passed large amounts of gas and liquid stools that at times were difficult to control. He had vomited intermittently for weeks, had lost 20 pounds in weight and had become quite weak. He was readmitted February 2, 1933. There were fulness in the lower abdomen, almost hourly intervals of borborygmus, sharp crampy pain, and three to four loose stools a day. Roentgenologic examination showed stasis in the small intestine situated in the right lower abdomen. Operation, February 6, 1933. The right lower quadrant of the abdomen was filled with a mass of adherent small intestines which were found to be the previously obstructed lower portion of the ileum. There was still a partial obstruction in the side-tracked loop about 40 cm from the previous ileocolostomy, due to the dense adhesions which narrowed the lumen of the gut to about one-quarter of its usual diameter. There was also a mass of very large, nonsuppurating mesenteric lymph nodes present. This portion of the ileum was quite friable, and on separating the adhesions, the serosa was torn. Numerous ulcers of the mucosa were found just proximal to the obstruction. The entire side-tracked portion of the ileum was gently freed and resected down to the cecum. The cecum and ascending colon were not resected. Convalescence was uneventful except for the diarrhea, which persisted for almost three months following operation.

*Follow Up Report*—Four years and nine months after operation the patient was completely well. No further pain, diarrhea or indigestion. He had gained 25 pounds in weight.

*Summary*—A man, age 29, following an appendicectomy, developed repeated attacks of acute intestinal obstruction which finally required an ileocolostomy around the obstructing ileal adhesions. Diarrhea abdominal pain, with loud gurgling, vomiting and loss of weight ensued. The condition was completely relieved eight months later by resection of the side-tracked loops of ileum, which showed an ulcerative colitis proximal to a persisting stenosis caused by the dense adhesions.

**Case 5**—A female, age 30, was admitted August 5, 1936. Nine years previously she had had a bilateral oophorosalingectomy and an hysterectomy performed elsewhere for, apparently, a severe pelvic inflammatory condition. Ever since, patient has been exceedingly nervous accompanied by an almost continuous series of hysterical manifestations.

In July, 1934, she had had a cholecystectomy for chronic cholecystitis. In January, 1935, she was readmitted with symptoms of acute intestinal obstruction. At operation no acute obstruction was found, but there were adhesions of the ileum 90 to 100 cm from the ileocecal valve, and a coil of intestine which had become caught beneath adhesions of the mesentery of the ileum to that of the cecum caused a kinking and partial obstruction. Simple freeing of the constricting adhesions did not promise complete relief. An anastomosis, therefore, was effected between a loop of ileum above and one below the adherent area. Convalescence was uneventful. She remained comparatively well for nine months. Ten months before readmission she began to have mild attacks of diarrhea and vomiting with severe epigastric pain radiating to the back. At first the attack

would last four to five days and recur only once in four to six weeks, but the last attack has persisted for four weeks with practically continuous diarrhea and frequent vomiting. On admission, by the use of a Wangenstein suction drainage tube, she was relieved for 48 hours, but the diarrhea—thin greenish stools—again began with sharp abdominal pain, synchronous with borboismus, but no visible peristalsis. Roentgenologic examination with a barium enema showed a patent ileocecal valve with dilated coils of terminal ileum (side-tracked coils). Exploration showed the old side-tracked loop adherent in coils, with no definite obstruction except that one adhesion to the cecum seemed to narrow the lumen. There were no enlarged mesenteric lymph nodes but there were a few small ulcers of the mucosa 5 to 10 cm proximal to the constriction. The involved side-tracked area was resected. There was no postoperative diarrhea. Convalescence normal.

Microscopic examination of the resected loop showed a small round cell infiltration involving all coats of the intestine, being most prominent in the mucosa, submucosa and serosa. In some areas polymorphonuclears, in others lymphocytes predominated. There was a scattering of eosinophiles. There was a definite perivascular round cell infiltration of the serosa. *Diagnosis:* Chronic interstitial ileitis.

*Follow Up Report*—Four months after operation. No further intestinal symptoms. No abdominal pain. Eating well. No indigestion, but has tremor of the left upper extremity and is bedridden (hysteria).

*Summary*—A woman, age 30, who, nine months after an ileo-ileostomy for intestinal obstruction due to intestinal adhesions, began to have attacks of diarrhea, vomiting, and abdominal pain, gradually becoming very severe and continuous, relieved by resection of the side-tracked ileum which showed a slight constricted area, and in which there were present an enteritis and a few mucosal ulcers.

*COMMENT*—Four cases are herewith recorded in which, following an entero-anastomosis to relieve an intestinal obstruction, due to massive adhesions, an enteritis of the obstructed loops developed, as evidenced by recurrent attacks of diarrhea, abdominal pain, overactive peristalsis, borboismus, and at times vomiting, which were entirely relieved by resection of the side-tracked loops. In these loops there were apparent stasis, some persistence of the obstruction or constriction of the gut, enteritis and ulceration. The ulceration was more evident, the more nearly the obstruction remained complete. This syndrome was quite similar to that appearing in a fifth case in which a long distal blind loop was permitted to remain beyond a lateral anastomosis, which was also cured by resection of the tremendously dilated blind loop.

Experimentally, we have demonstrated that an enteritis with ulceration can be produced in dogs by an anastomosis around an intestinal obstruction whether the anastomosis be an ileo-ileostomy or an ileocolostomy. Furthermore, in the experimental animal the enteritis may be found to extend into the ileum proximal and into the colon distal to the anastomosis. It, therefore, seems fair to assume that a similar condition may exist in the human and is responsible for the diarrhea that in some instances persists after resection of the involved loops.

Pearse<sup>5</sup> has recently reported experimental work similar to ours. He has shown in dogs that

(1) When a long blind loop is left proximal to an anastomosis for intestinal obstruction, peristalsis is away from the obstructed blind end, the loop empties easily, the dogs remain well

(2) When a blind loop is left distal to an anastomosis, the peristalsis is toward the obstruction or blind end, and he believes that

(a) Short jejunal loops up to one foot in length are tolerated well and empty themselves

(b) Loops from three to four feet long become filled with inspissated feces and debris and dilate enormously, if perforation does not occur, emaciation, anorexia, lassitude, and lethargy ensue and finally death

(c) Loops five to six feet long cause death from inanition and dehydration. In six dogs, as in two of ours, death occurred from peritonitis following perforation of an ulcer. Other superficial ulcerations were occasionally observed, but he believed they were due to pressure necrosis from bits of bone and foreign bodies that collect in these blind loops

He also described a clinical case which, six months after a lateral anastomosis around an obstruction, developed attacks, at intervals, of abdominal discomfort, anorexia, nausea, vomiting, and loss of weight. Resection of the side-tracked segment, which was thick, dilated and ulcerated, was followed by diarrhea for three weeks, after which the patient remained well

Pickhardt<sup>6</sup> refers to a right hemicolectomy and ileocolostomy which nine years later showed a dilated and elongated blind end of the ileum unaccompanied by symptoms. Stettin in discussing this case mentions the perforation of a similar blind loop

Vaughan,<sup>7</sup> in arguing for entero-anastomosis as against enterostomy in ileus, cited one case in which "symptoms were much improved by entero-anastomosis," but resection of the side-tracked intestine was necessary for complete relief, in another case, after anastomosis, recurring attacks of abdominal pain and vomiting persisted and resection of the adherent coils of small intestine was necessary in which "many obstructive points were encountered forming dilated bowel areas filled with fecal matter and pus." Three other of his cases remained well without resection

Little, Zerfos, and Tusler<sup>4</sup> report a case in which an anastomosis between the jejunum and the ascending colon and jejuno-ileostomy had been performed for intestinal obstruction. The patient had marked loss of weight with periodic abdominal cramps, vomiting, diarrhea, marked anemia, and visible peristalsis. The entire small bowel between the first anastomosis and cecum was markedly distended, thickened, and filled with liquid bowel contents. Both anastomoses were taken down and the piece of jejunum between the openings was resected with end-to-end union. The excised bowel showed marked hypertrophy of the muscle, edema and hemorrhage. The abdominal symptoms were relieved but a primary type of anemia with fatigue, anorexia, and loss of weight persisted, which, however, responded to liver extract and the usual pernicious anemia therapy

Christopher<sup>1</sup> describes a similar case in which after a jejunocolostomy for obstruction, meteorism, flatulence, belching, tremendous appetite, marked pallor and anemia developed. The entire small intestine was enormously distended and the walls thickened, but there was no evidence of ulceration. The

terminal ileum was markedly adherent. The jejunocolostomy was taken down and an ileocolostomy around the adherent coils of ileum was followed by rapid recovery. Umy, Ragle, Allen and Jones<sup>8</sup> have reported a case of beriberi following short circuiting of the small intestine.

Apparently, therefore, both Vaughan and Pearse have observed cases presenting symptoms similar to ours, which have been cured by resection of the side-tracked intestine. Also, Christopher and Little, Zerfos, and Trusler's experiences with very long side-tracked loops of small intestine, as well as Pearse's experiments with dogs, indicate that an entero-anastomosis, short circuiting long lengths of small intestine, may lead to grave anemia and serious toxemia.

#### CONCLUSIONS

(1) Entero-anastomosis for intestinal obstruction due to massive adhesions may be a very useful procedure but it may have certain limitations and complications.

(2) Following an anastomosis around a mass of intestinal coils obstructed by adhesions, if the obstruction persists, there will follow an ulcerative enteritis of the obstructed loops with perhaps a general enterocolitis, as evidenced by diarrhea, abdominal pain and borborygmus. Resection of the side-tracked intestine will be necessary. Even stenosis or a persistent partial obstruction may lead to a similar syndrome.

(3) Entero-anastomosis for intestinal obstruction must be looked upon as a possible first stage operation of which resection of the obstructed loops may be required at a second stage.

(4) In the presence of acute obstruction it would be unwise to consider primary resection of the obstructing loops, but if at the time of operation it seems likely that the obstruction will remain, the two stage operation should be definitely planned.

(5) It is further suggested that, as an alternative procedure to a lateral anastomosis around the obstruction, the intestine might be divided as close to the obstructive lesion as possible, followed by an end-to-side anastomosis below the obstruction. In this manner a proximal instead of a distal blind end would be left which should drain normally, give no symptoms, and require no further operative procedure.

(6) Short circuiting very long lengths of small intestine may lead to serious toxemia, grave anemia, or a syndrome similar to beriberi.

#### REFERENCES

- <sup>1</sup> Christopher. *Am Jour Surg*, New Series, 29, 124, 1935.
- <sup>2</sup> Estes and Holm. *ANNALS OF SURGERY*, 96, 924, 1932.
- <sup>3</sup> Holm. *Surg, Gynec, and Obstet*, 56, 746, 1933.
- <sup>4</sup> Little, Zerfos and Trusler. *J A M A*, 93, 1290, 1929.
- <sup>5</sup> Pearse. *Surg, Gynec, and Obstet*, 59, 726, 1934.
- <sup>6</sup> Pickhardt. *ANNALS OF SURGERY*, 97, 116, 1933.
- <sup>7</sup> Vaughan. *Trans Amer Surg Assoc*, 48, 266, 1930.
- <sup>8</sup> Umy, Bagle, Allen and Jones. *New England Med Jour*, 210-251, Feb, 1934.

## A CONTROLLABLE CECOSTOMY

WM PERRIN NICOLSON, JR, M D

ATLANTA GA

CECOSTOMY is perhaps the most advantageous method of decompressing an obstructed colon. It may be used as a preliminary to a subsequent resection of the colon, or as a safety valve in cases in which a resection of part of the left colon is followed by primary anastomosis. It is usually a temporary procedure but may have to serve as a permanent opening. Rankin urges that no exploration be carried out in cases of acute obstruction from a malignancy at the time cecostomy is performed. In a certain number of such cases at the time of the second operation, the growth is found to be inoperable, or there is metastatic involvement of the liver. In these cases the cecostomy is left as a permanent relief for the obstruction.

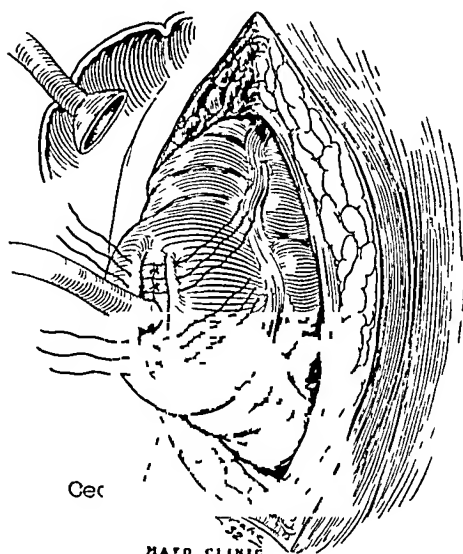


FIG 1—Showing the technic of using a de Pezzer catheter in performing cecostomy (From 'The Colon, Rectum and Anus' Rankin, Bergen, Bue, W. B. Saunders)

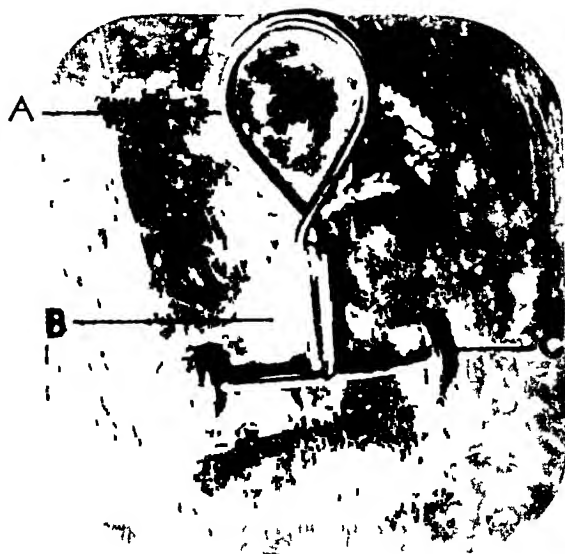


FIG 2—A piece of monel metal approximately ten centimeters square on which has been soldered a clamp (A). One handle is left free so that pressure at (C) will open the clamp, and the end of catheter is brought through (B) while the clamp is open.

Whether temporary or permanent, it is highly desirable that the drainage from the colon be controlled. It not only makes the patient much more comfortable and happier, but also makes the probability of contamination at the second operation much less likely.

No originality is claimed for the method of performing the cecostomy. A large de Pezzer catheter is used after having cut off the top of the mushroom end. The cecum is delivered through a McBurney incision and a rubber covered clamp applied. The catheter is then introduced into the cecum in the manner described by Gibson (Fig 1), as modified by Hendon and Rankin. A purse string suture is placed in its wall and the cecum opened, the catheter

introduced and suture tied. Reinforcing sutures or a second purse string is inserted and the cecum is attached to the parietal peritoneum. The cecal or colonic contents thus drain through this catheter, which in turn may be connected by a glass tube to a long rubber tube and drained into a bottle. This works well as long as the patient is in bed. There is practically no contamina-

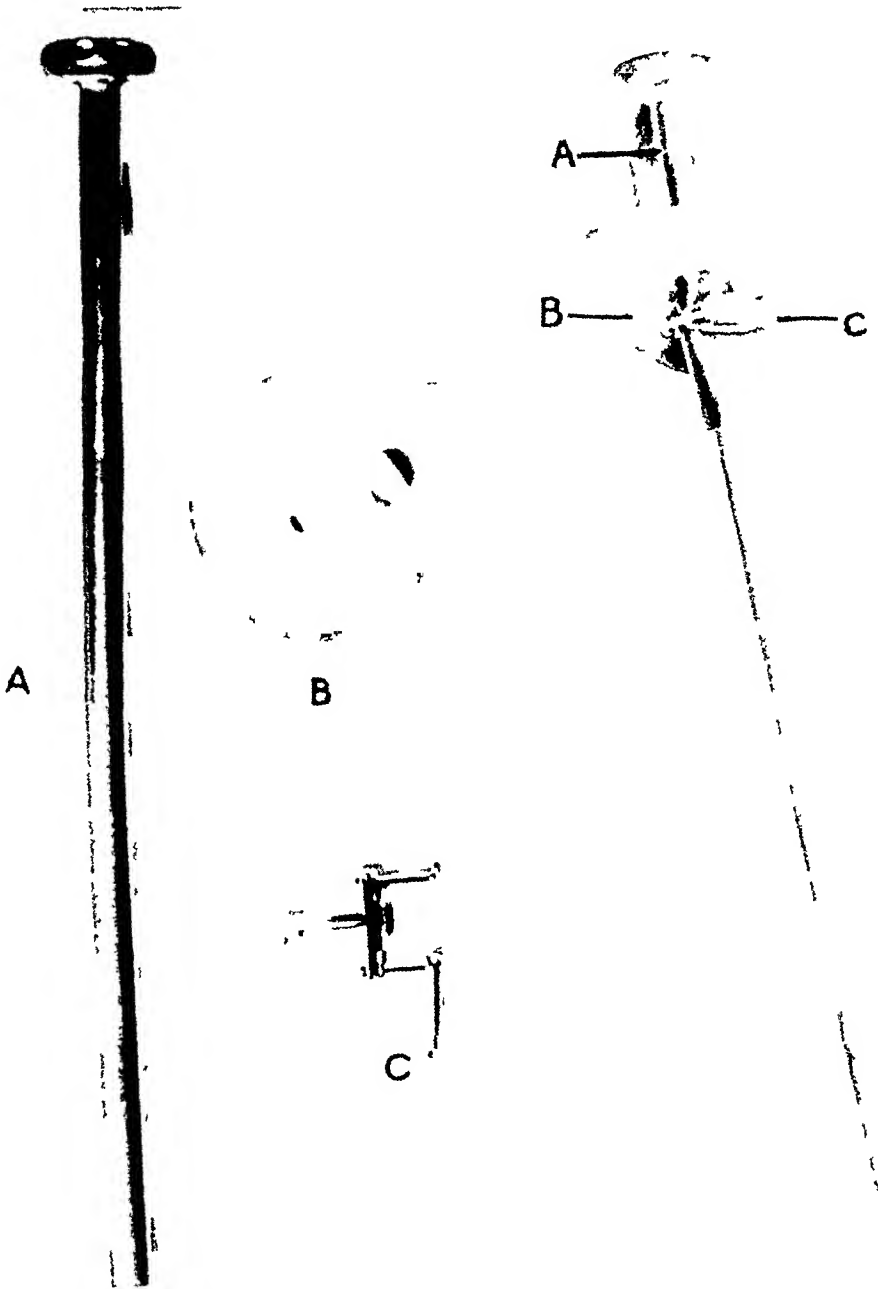


FIG 3—(A) Open end de Pezzer catheter  
(B) Rubber retention disk (C) Clamp from  
clavis set

FIG 4—Parts shown in Fig 3 as  
sembled

tion of the dressings. When the second stage is attempted, if metastases are found in the liver, the cecostomy is left a permanent one.

In such cases, or where the second stage is not performed immediately, it is desirable for the patient to get out of bed. The tube then has to be removed and fecal contamination is not controlled. In an attempt to control this, a hole (Fig 2B) exactly the size of the catheter was drilled in a piece

of monel metal ten centimeters square, and a climax clamp (Fig 2A) was soldered on one side. The end of the catheter was put through the opening and some gauze placed between the metal and the patient's skin. The metal plate was held in place by adhesive strips and more dressings applied over it. Each morning the clamp was opened (by pressure at Fig 2C) and a colon irrigation given. At intervals during the day the clamp was released to allow the patient to pass feces.

The patient was able to get out of bed and live as normal a life as her strength would permit. At first it was thought that the catheter would probably work loose and come out. It did not. In the first case in which it was used, after being in place for many months, the catheter was removed, because of irritation of the edges of the wound. The patient was confined to her bed at this time and the tube was never replaced. A copper tube, about five inches long and slightly larger than the catheter, had been secured to aid in replacing it if necessary. The mushroom end was to be pulled into the metal tube, which in turn was to be introduced into the cecum through the well established sinus. Then the catheter could be pushed out of the tube into the colon.

It was felt that a rubber protecting disk would be more comfortable than a metal plate, and such a "retention disk" (Fig 3B) was found. It is usually employed over a de Pezzer catheter after suprapubic cystostomies. This apparently would work over a cecostomy tube also. One was tried and was held in place either with liquid adhesive or strips of adhesive plaster and proved much more comfortable. A clamp from a clysis set (Fig 3) is used to close the tube and can be easily managed by the patient. Instead of cutting off the top of a catheter, an open end de Pezzer catheter (Fig 3A) can be obtained and is more satisfactory (Figs 3 and 4).

By the simple means of using a metal or rubber shield, and a clamp, the fecal discharge of a cecostomy can be controlled, thus preventing the contamination of the field if a second operation is needed, and making the patient much happier and more comfortable if the cecostomy has to be left as a permanent one.

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## THE TECHNIC OF COLPOPERINEORRHAPHY

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THE surgical cure of rectocele requires an operation that affords an ample dissection of the lesion, its correction by plication or rectopexy, the suturing of the levators to the side of the rectum, the obliteration of dead space, the exact approximation of the vaginal mucous membrane, and an adequate repair of the perineum. These requirements have been repeatedly noted by numerous authors and their achievement is the objective of all operators.

Annoying hemorrhage, however, is frequent and at times prevents the surgeon from adequately carrying out his technic. It is the purpose of this

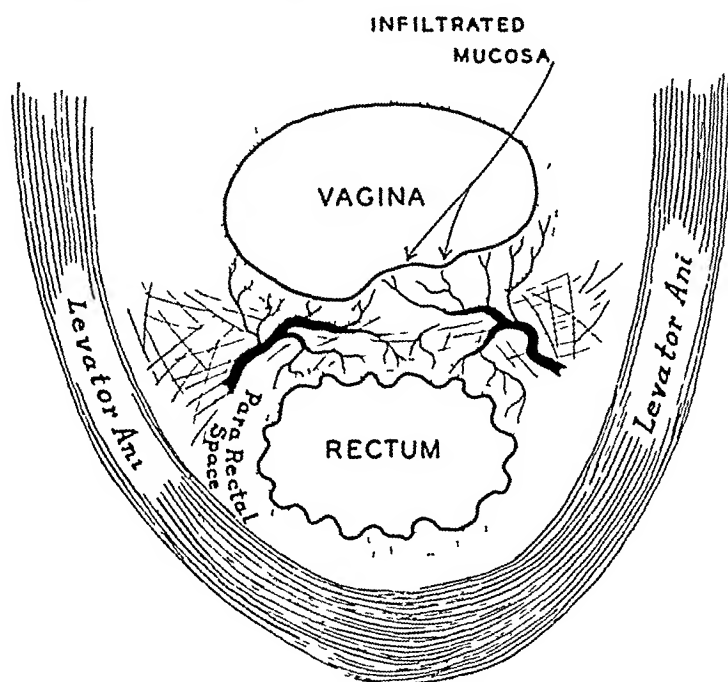


FIG 1—Diagram showing location of blood vessels in the wall of the vagina and the effect of infiltration of the field with adrenalin in novocain.

paper to present a method of dissection, based on anatomic considerations, which will do much to control the hemorrhage and thereby facilitate the operation.

Many of the blood vessels supplying the posterior wall of the vagina run in a rather definite bundle in the fascia. Their course is obliquely downward and inward, and they can be seen in the vaginal fascia, on the posterolateral aspect, about three-fourths to one and one-fourth inches from the introitus.

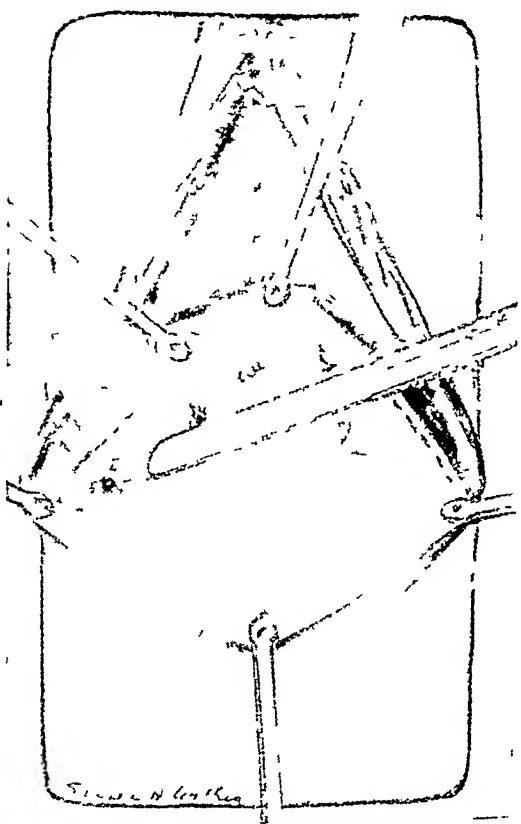
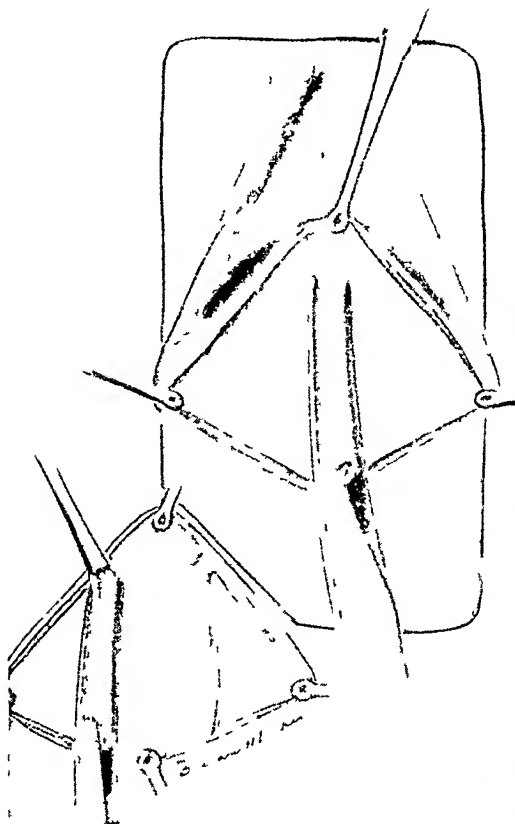
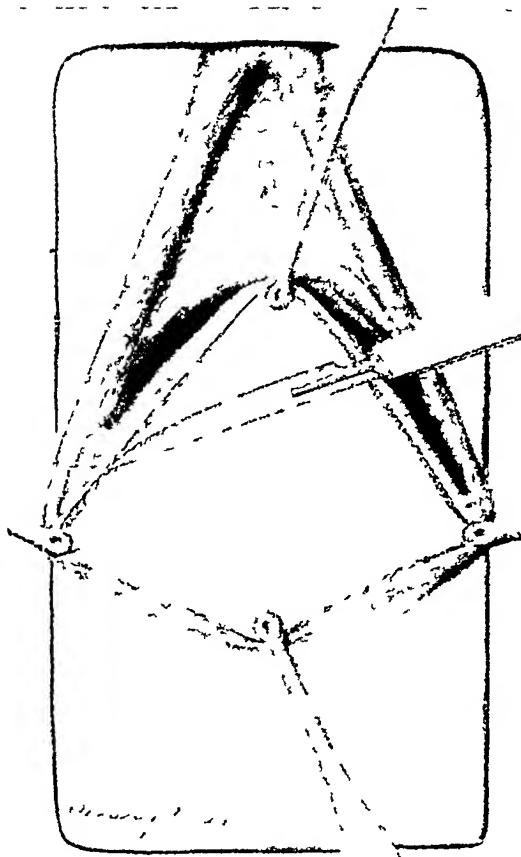
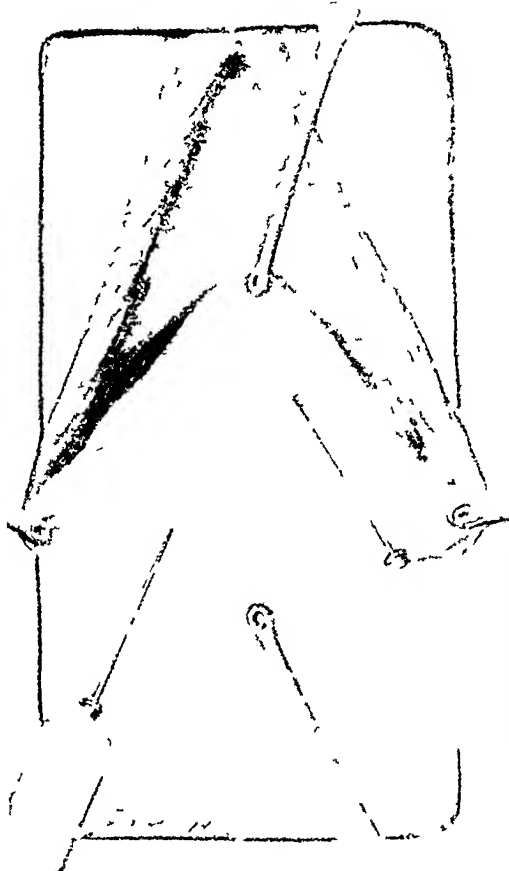


FIG 2—The rectocele is caught with clips and the field infiltrated with adrenalin in novocain

FIG 4—The mucous membrane is removed with scissors

FIG 3—The area to be denuded is outlined with the scalpel

FIG 5—The vessels are identified The pararectal space is opened and the levators are exposed

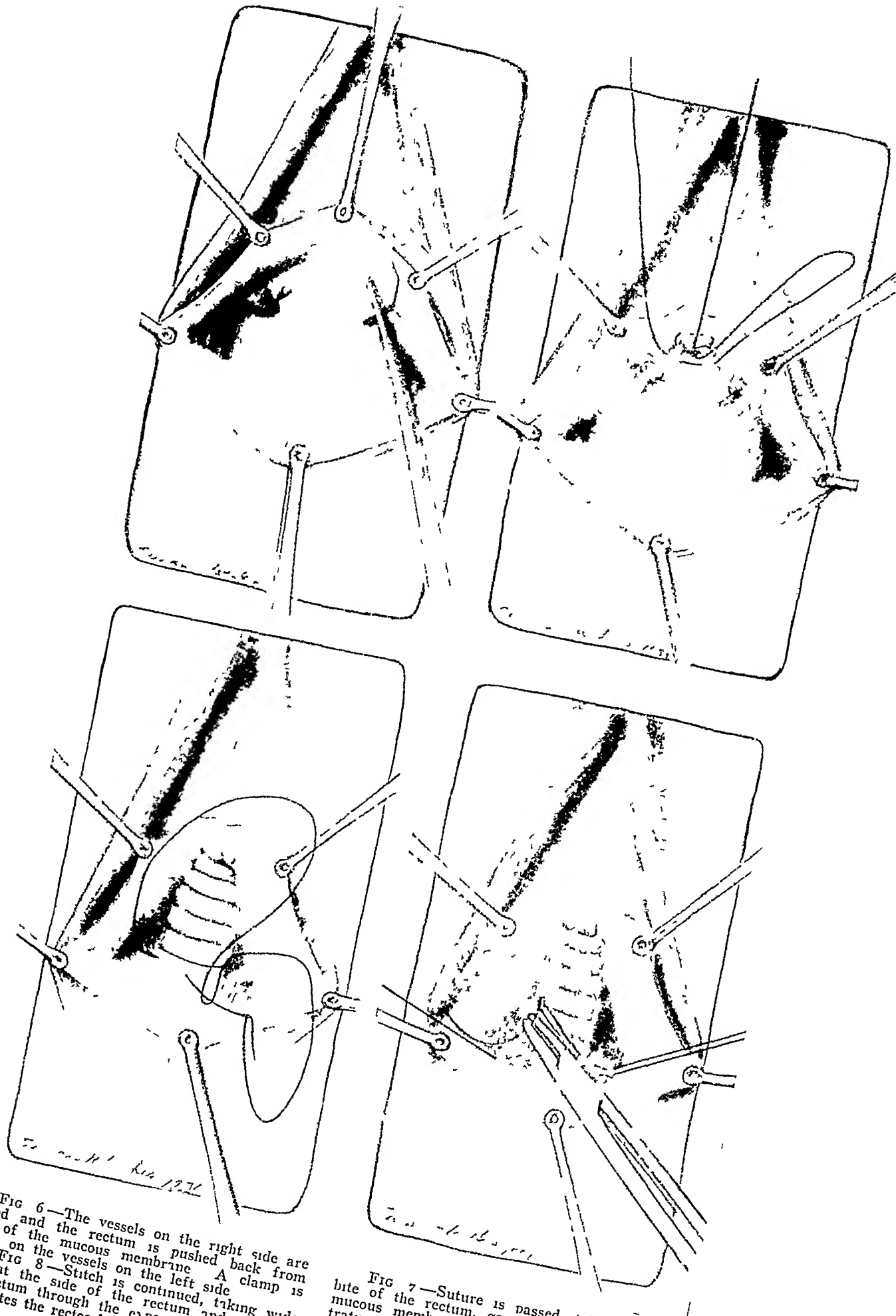


Fig 6—The vessels on the right side are ligated and the rectum is pushed back from edge of the mucous membrane. A clamp is shown on the vessels on the left side.

Fig 8—Stitch is continued, taking wide bites at the side of the rectum and plicating the rectum through the exposed portion. This obliterates the rectocele.

Fig 7—Suture is passed taking a small bite of the rectum, going through the vaginal mucous membrane crossing the midline, penetrating the vaginal mucous membrane, and taking a bite of the rectum. It is tied in the midline.

Fig 9—The levator sutures are passed.

They run toward the midline, breaking up into many small branches before they penetrate the fascia on their way to the mucosa (Fig 1) It is obvious that, if one can remove the mucous membrane without going deeply into the fascia, the larger vessels will not be opened A thorough preliminary injection of the field with adrenalin in novocain will separate the mucous membrane from the fascia and check the blood flow from the smaller vessels The mucous membrane can be removed with scissors, after which the field is so dry that the vessels can be identified and ligated before exposing the sides of the rectum The ligation of these vessels greatly decreases the

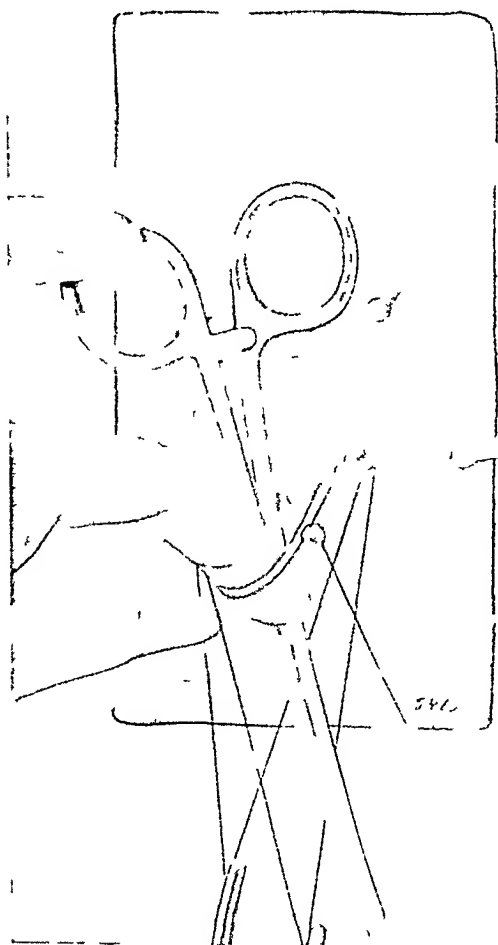


FIG 10—The inner portion of levator sutures are hooked upon the finger withdrawn from the wound, and held by engaging the handle of a clamp in them

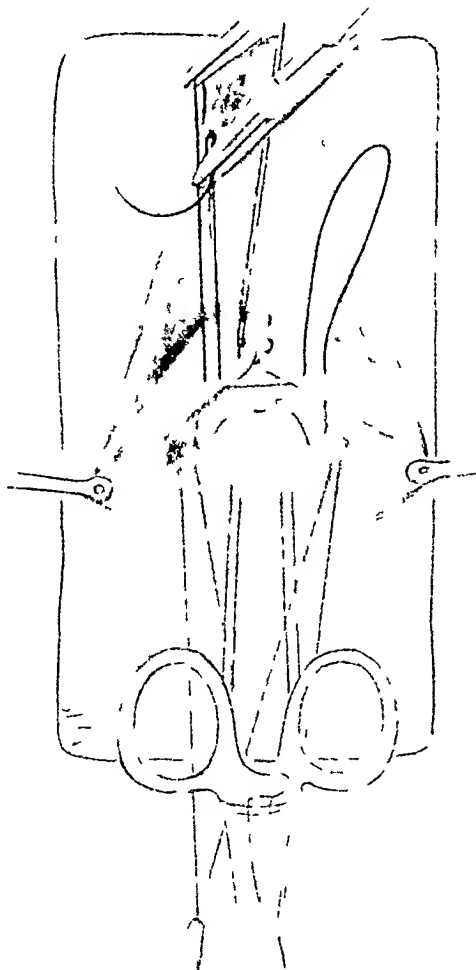


FIG 11—The first two on edge mattress sutures are tied The deep portion of the third suture penetrates the vaginal mucous membrane takes a bite of the levator fascia, is reefed through the top of the rectum and the levator fascia of the opposite side, and penetrates the vaginal mucosa

hemorrhage and allows the operation to proceed smoothly The details of the dissection will be found in the following description

*Operative Technic*—(1) The mucous membrane of the vagina is caught with mucosa clips at the carunculae myrtiliformes, at the top of the rectocele, and in the midline at the mucocutaneous junction The field, as well as the area adjacent to it, is thoroughly infiltrated with adrenalin (1:20,000) in  $\frac{1}{4}$  per cent novocain (Fig 2)

(2) The area to be denuded is outlined with a scalpel (Fig 3)

(3) The mucous membrane is removed with scissors (Fig 4)

(4) The vessels are identified. A mucosa clip, placed on the mucous membrane above the vessels, draws it toward the symphysis. A finger is placed on the mucous membrane behind the clip and pushes its under surface into view. The vaginal fascia at this point is incised with a scalpel and, after very gentle dissection with the knife handle, a finger will open the para-rectal space. The levators are well exposed laterally and the vessels stand out superiorly and medially. These are clamped and cut (Fig 5)

(5) The vaginal fascia is now incised superiorly to the vessels and the rectum is pushed back about one-half inch from the edge of the mucous membrane. The entire field is now exposed, and the rectocele can be reduced by plication or rectopexy (Fig 6). Plication will be described.

(6) A needle, armed with No 1 chromic catgut, enters the fascia at the left side of the rectum, penetrates the vaginal mucous membrane in an upward direction, crosses the midline, penetrates the mucous membrane in a downward direction, grasps the fascia at the right side of the rectum, and is tied (Fig 7)

(7) The suture is continued, plicating the rectum, and is tied at the lower angle of the wound. This obliterates the rectocele (Fig 8)

(8) The levator sutures are passed, and the ends clamped (Fig 9)

(9) The inner portion of the levator sutures are hooked upon the finger, withdrawn from the wound, and held by engaging the handle of a clamp in them (Fig 10)

(10) The sides of the rectum and levator are reapposed by the use of interrupted on-edge mattress sutures of No 1 chromic catgut. This suture obliterates the dead space and adequately approximates the vaginal mucous membrane without inversion. In passing the suture, a needle is threaded at both ends of the suture. One needle enters the mucous membrane three-eighths of an inch from the edge, picks up the fascia at the left side of the rectum, passes over the rectum (picking it up at one or more points), grasps the fascia at the opposite side, and then passes out through the mucous membrane. The other needle is passed through the edge of the mucous membrane, on each side, and the suture is tied. Sutures are inserted in this manner until the incision in the mucous membrane is closed (Fig 11)

(11) The levator sutures are tied, the trigone is closed with interrupted sutures and the skin is closed with clips (Fig 12)

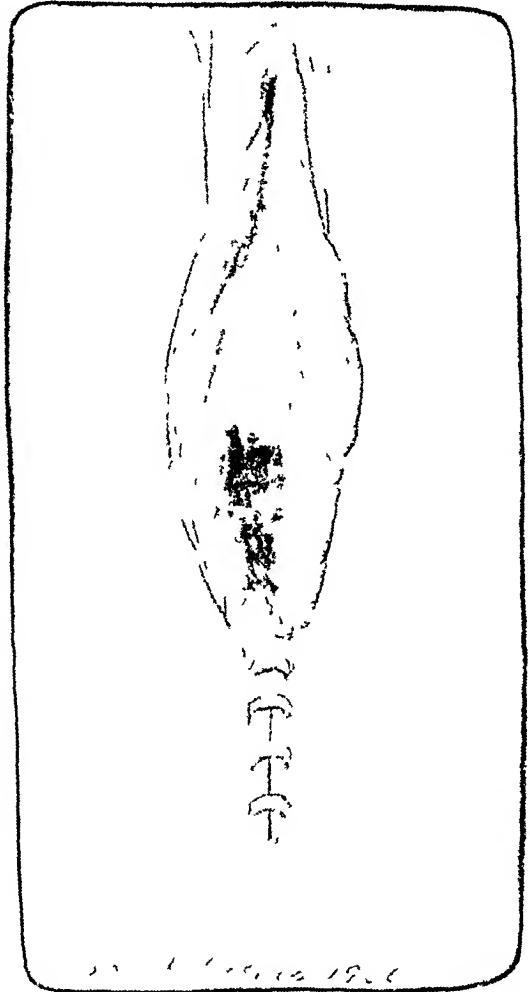


FIG 12—The trigone is closed with interrupted sutures and the skin is closed with clips

## ECHINOCOCCUS DISEASE

REPORT OF A CASE OF PRIMARY ECHINOCOCCUS CYST OF THE UTERUS  
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ECHINOCOCCUS or hydatid disease, recognized since the time of Hippocrates, is caused by the *Taenia echinococcus*, a minute tapeworm, two and one-half to five millimeters long, which finds its host in the intestines of the dog, and more rarely, of the cat, the jackal, and the wolf. The larvae are excreted in the feces of these animals, and vegetation and unprotected water supplies thereby contaminated. The wind-blown dust and the running streams carry the eggs, microscopic in size, far and near. Human beings, domestic animals, grazing cattle, and swine become the intermediate hosts in the parasitic cycle by ingestion of the egg embryos, or by direct contact with infected animals. Davis and Balboni<sup>1</sup> state that 27 species of mammals have been reported as harboring echinococcus disease, also that the dog is not itself subject to the hydatid form which is the larval stage and occurs only in the intermediate host. If the dog is fed upon flesh or viscera containing hydatid cysts, it develops in turn an adult tapeworm and the cycle is completed. However, as Magath<sup>2</sup> and others report, proof of the presence of the adult type in the dog is rare in North America, and the only authentic record is that of Cuttice who found it in one dog at Washington, D C. Von Siebold was the first to rear *Taenia echinococcus* experimentally in the dog by feeding it hydatids removed from cattle.

When the eggs of the *Taenia echinococcus* are swallowed by the intermediate host, the embryos are set free by the digestive processes, burrow by means of hooklets into the walls of the stomach or intestines, and are carried by the systemic circulation, or as some authorities believe, by lymph channels, to various parts of the body. When the embryo reaches its final destination in the liver, heart, lungs, *etc*, the hooklets disappear and the embryo is gradually transformed into a cyst with two layers, containing a clear fluid, and wholly enveloped by a fibrous covering. From the internal germinative layer, daughter cysts develop inside of which are brood capsules each composed of two or more heads or scolices capable of becoming a tapeworm if excreted by the secondary host and ingested by the parent host, the dog. And from the daughter cysts, granddaughter cysts form, until the whole mass may become as large as a child's head.

There are two types of cysts. *Echinococcus unilocularis*, and *echinococcus multilocularis*, the latter being the rarer type.

The disease is a menace to public health in many sections of the world. Pomerania, Mecklenburg, Bavaria, Switzerland, certain provinces of Italy,

parts of France, Greece, Armenia, Yugoslavia, the steppes of Russia, and Turkey. In Iceland, it is the cause of one-seventh of the deaths. In Australia and New Zealand it is quite common. Barnett,<sup>3</sup> in a statistical survey of hydatid disease in New Zealand for the period of 43 years ending in 1934, estimated 3,550 cases, with the deaths for the whole Dominion, 534, and a mortality rate of 15 per cent. In a personal communication to the authors, he states that in New Zealand with a population of 1,500,000 there are approximately 125 new cases of hydatid infestation every year. A Hydatid Registry has been established under the auspices of the Royal Australasian College of Surgeons to record and tabulate the cases, and to date approximately 1,000 cases have been so registered and analyzed and about 200 additional cases have been briefly noted.

In the Argentine Republic, Uruguay, and southern Brazil, the incidence is high and all leading surgeons in Buenos Aires and Montevideo are thoroughly versed on echinococcus cysts. In 1922, the Argentine Medical Association devoted an entire week to the study and discussion of hydatid disease and published an extensive bibliography. In 1932, Félix Devé, Professor of Medicine at the University of Rouen, one of the foremost authorities on the disease, delivered a series of lectures on echinococcosis by special invitation of the Medical Association of Buenos Aires.

In North America, echinococcus disease is more prevalent than commonly supposed, and although the literature from Canada and the United States is not so voluminous as that from other parts of the world, a great number of cases have been reported. Lyon,<sup>4</sup> in 1902, assembled 241 cases. In 1921, Magath (in addition to 68 previously reported cases) cited 25 cases from The Mayo Clinic. And in 1927, Mills<sup>5</sup> added 63 hitherto unpublished records. In all, the literature since 1902, through the year 1935, contains reports of 268 cases, making the grand total of reported incidence 509 cases. And the fact that there were 155 deaths from hydatid cysts (111 of the liver, 44 of other organs) in the United States during the five years ending in 1934 makes it extremely probable that there were as well a goodly number of cases not reported in scientific articles.

In the past, it has been persistently argued that the incidence in North America was only among foreigners or those who had lived in countries where the infestation was rife. The case we are reporting was in a Negress, who not only was native born, but had never been outside the state, living always near Alexandria, La., at first 20 miles north of that city and more recently the same distance south of it, nor had she ever been in intimate contact with a person from outside the state. In Lyon's review of 241 cases, 135 were among foreigners, 92 nationality not stated, and of the remaining 13, ten were Negroes, two Canadians, and one American. Of the 268 cases since 1902, there were 41 whose nativity was not known, 26 Americans, and two Canadians, or 12.3 per cent native born, and 199 foreigners, or 87.7 per cent (Table I).

TABLE I

NATIVITY OF THE 268 CASES REPORTED SINCE 1902

Albania	1	Poland	1
Armenia	8	Portugal	2
Austria	10	Roumania	1
Cape Verde Islands	1	Russia	13
England	12	Spain	2
Finland	1	South America	3
France	2	Syria	2
Germany	11	Sweden	1
Greece	36	Turkey	2
Hungary	1	Wales	3
Iceland	15	Yugoslavia	2
Ireland	3	Foreigner (country unknown)	4
Italy	58	Canada	2
Mexico	1	United States	26
New Zealand	2	Not known	41
Native born		12 3 per cent	
Foreign born		87 7 per cent	

Riley<sup>6</sup> believes that the assertion of a number of workers that the majority of cases occur in foreign born individuals, or those who have traveled in endemic regions, is not a sufficient explanation in view of the frequency of the disease in domestic animals. And this seems plausible, for echinococcus infestation occurs in hogs, sheep, and cattle in alarming numbers in Virginia, Oklahoma, and Arkansas.

It has been impossible to get any statistics from the Federal Government or the packing houses as to the incidence of the disease in animals slaughtered throughout the country, other than that (from the Bureau of Animal Industry, Washington, D. C.) during the fiscal year ended June 30, 1936, there were reported condemnations of 1,513 cattle livers and 21 calf livers on account of echinococcus infestation. Therefore, it is easily possible that in districts where the meat supplies are not carefully guarded, and hogs, sheep, and cattle are home killed and the offal is thrown to dogs to eat, the vicious circle of infestation is fostered and encouraged and the human incidence increased.

When echinococcus disease travels by its route of contamination from animal to man, the liver for anatomic reasons is the site most often invaded.

TABLE II

PERCENTAGE OF INCIDENCE OF ECHINOCOCCUS AT VARIOUS SITES IN MAN

Author	Liver	Lungs	Other Organs	Abdom- inal Cavity	Skin and Muscles	Brain	Kidney	Spleen	Bone	Heart
Devé	74.9	8.5	4.2		5.7	1.4	2.1	2.3	0.9	
Thomas <sup>7</sup>	57.0	11.6	18.4			4.4	4.7	2.1		1.8
Lyon	73.7									
Beckman <sup>8</sup>	75.0	9.0	16.0							
Stitt <sup>9</sup>	60.0	10.0	8.0	7.0	7.0	3.0	3.0	2.0		
Mills <sup>10</sup>	75.0									
Barnett	70.0	10.0	20.0							
Magath	76.3									



Various writers have estimated the percentages of incidence, as shown in Table II

Analysis of the 268 cases recorded since 1902 shows the location of the cysts to be as noted in Table III

TABLE III

LOCATION OF CYSTS IN THE 268 CASES RECORDED SINCE 1902

Organ	Cases	Percentage
Liver	212	69 7
Lungs	22	7 0
Kidney	17	5 5
Bladder	1	0 3
Abdomen	8	2 6
Peritoneal cavity	21	6 8
Pelvis	4	1 3
Spleen	4	1 3
Retroperitoneal	2	0 6
Heart	2	0 6
Pleural cavity	4	1 3
Gallbladder (2) and bile duct (1)	3	0 9
Neck	1	0 3
Bones	3	0 9
Brain	1	0 3
Prostate	1	0 3
Spinal cord	1	0 3

Echinococcus cysts of the female pelvis and uterus have been noted from time to time in the foreign literature. However, some of these upon investigation appear to have been not true echinococcus cysts but hydatiform moles. Confusion between the two seems frequent in the literature of the last decades of the nineteenth century and in the cases cited during that period, in the absence of microscopic confirmation, there is always doubt as to validity. In 1891, a case of echinococcus cyst of the uterus was reported by Altomyan<sup>11</sup> from Aleppo, Syria. John Davies Thomas quotes Neisser's report of 35 hydatids found in the true pelvis, 20 in females, 15 in males, besides these there were 27 cases in which the uterus or ovary was considered to have been the seat of the parasite. Thomas also mentions the report of Schatz giving 66 instances of hydatid disease in the female pelvis, as well as a case recorded by Allen of a large hydatid cyst found at autopsy "in the pouch between the bladder and the uterus", and another case "attached to the peritoneum covering the fundus of the uterus and the bladder. In Thomas' own series the uterus is credited with 29 instances and the ovary with 16. He also gives a list of 72 pelvic cases, 14 in the uterine wall, eight in the ovary, and seven in the broad ligament. Unfortunately, no definite references are given upon which to base the authenticity of Thomas' statistics, his book is a collection of lectures and there are gaps in the context, as some of the data were lost previous to compilation of the book.

During the present century also, echinococcus cysts of the female genera-

tive organs have been reported from abroad Mills cites one from the Argentinians (Cuneo) of an echinococcus cyst of the ovary in a girl, age 15, and another (Chueco) of the posterior wall of the uterus in a virgin, age 15 Cuff<sup>12</sup> reports an echinococcus cyst of the uterus from Cyprus The literatures of France, Germany, and Scandinavia also contain references to echinococcus cysts of the uterus The conclusion is, therefore, that it is not an unknown condition, but is by no means common, and the rate of incidence cannot be compared with that in other organs As a rule, the cyst of the uterus is secondary to affection of the liver, kidneys, *etc* Turenne<sup>13</sup> states that primary hydatid cysts of the uterus are so rare that he has only been able to find 10 in the literature, in addition to the one he personally reports, and that Mercade found 14 cases, of which only eight were primary cysts of the uterus Barnett, in a recent personal communication, agrees that primary hydatid cysts of the uterus are extremely rare, probably as rare as those occurring in the thyroid gland, the heart, or the prostate In the Hydatid Registry cases there is only one that can without any doubt be classed as primarily uterine

**Case 952**—Found by Dr K Christie, July 5, 1936, at operation for uterine fibroids Two large fibroids were removed, a third mass the size of an orange embedded in the anterior wall of the uterus, between the uterus and the bladder, was also excised on the assumption that it was another fibroid, but subsequent examination showed it to be a hydatid cyst containing the typical fluid and daughter cysts

In North America, very few echinococcus cysts of the female pelvis are recorded Lyon includes three in his review, and McKechnie<sup>14</sup> and Kerwin<sup>15</sup> each report a case (Table IV)

TABLE IV

## ECHINOCCUS CYSTS OF THE FEMALE PELVIS REPORTED FROM NORTH AMERICA

Case	Location	Observer
Female, age 73, from Albany, N Y	Liver and ovary	Low (1822)
Female, from Toronto, Ont	In walls of pelvis, two cysts in liver, rupturing into intestine	Cameron (1882)
German female from Argyle, Ill	Bladder, pelvis, liver, spleen, kidney, omentum, peritoneum, diaphragm, and pericardium	Allaben (1891)
Female, age 40, born in Iceland	Pelvis and bladder	McKechnie (1910)
Female, age 44, born in U S	Pelvic peritoneum	Kerwin (1916)

Of the cases of echinococcus cyst of the uterus reported from North America, none is proven primary, and some are obviously spurious Lyon omits all but one (Van Giesen) from his review as of doubtful validity, and the histories indicate very positively that the cysts were of chorionic and not of parasitic growth (Table V)

We, therefore, believe there is justification for our claim that we are reporting the first case of echinococcus cyst of the uterus in the United

TABLE V

ECHINOCOCCUS CYSTS OF THE UTERUS REPORTED FROM NORTH AMERICA

Platt (1847) "Hydatid in utero"	Included by Sommer but omitted by Lyon as of doubtful validity
MacNevn (1849) Cyst of uterus coexistent with pregnancy and expelled intact during labor	Not definitely proven parasitic Not included by Lyon
Smith (1856) "Hydatids in utero"	Included by Sommer but omitted by Lyon as of doubtful validity
Ford (1868) "Hydatids in utero"	Included by Sommer but omitted by Lyon as of doubtful validity
Henry (1871) No record except entry in report of Montreal General Hospital "Hydatides uteri, discharged"	Of doubtful validity, not included by Lyon
Gross (1882) Hydatid of uterus	Not definitely proven parasitic Not included by Lyon
Van Giesen (1887) "Multiple cysts liver, omentum, abdominal wall, peritoneum, fascia of psoas muscle, mesentery, and uterus	Included by Lyon, but obviously not a primary cyst of the uterus

States, in a native born female, as well as the first primary echinococcus cyst of the uterus from North America

Mills, Devé, and other authorities point out that the seeds of echinococcosis are sown in infancy and the majority of hydatid cysts cause no symptoms until the patient has attained the age of 20 to 40 years Stitt notes that the growth of the cysts is slow and the course of the disease is protracted two to eight years Davis and Balboni cite the case of Magnusson, who had had it under observation for 40 years And, as Dew<sup>16</sup> puts it, the majority of cysts, as seen clinically, are nearly as old as their hosts Whether infestation occurred in childhood in the present case is, of course, a matter for conjecture

The symptoms of echinococcus cysts are those of any slowly growing tumor, and in the absence of complications of the liver, as in this case, there is a symptomless enlargement until the size of the cyst produces discomfort

When echinococcus cysts are suspected before operation, it is sometimes possible to confirm the diagnosis by certain laboratory tests the precipitin test of Fleig-Lisbonne, the complement fixation test of Boidet Gengou, which is based upon the Wassermann reaction and was first applied by Ghedini in 1906, and the Casoni skin reaction But none of these tests is infallible, nor is roentgenologic diagnosis, nor is it always possible to elicit hydatid thrill or fremitus, said to be present in 30 per cent of the cases A high eosinophilia is sometimes indicative, in the present case, eosinophiles were only 1 per cent

The treatment of echinococcus cysts is purely surgical Davis and Balboni believe the use of salvarsan, as proposed by Kolbe, is not effective and that tapping the cysts through the abdominal wall is to be condemned because of danger of leakage of the fluid and daughter cysts into the peri-

toneal cavity with dissemination of the disease. When possible, excision en masse is the procedure of choice, but this is very seldom feasible, especially in echinococcus cysts of the liver. Therefore, marsupialization, with or without postoperative drainage, must be resorted to. Briefly, the accepted method is to aspirate the cyst contents and then inject a 1 to 2 per cent formalin solution, leaving it in about five minutes, in order to kill the scolices. Dew recommends injecting enough pure formalin to make, with the fluid remaining in the cyst, at least a 1.5 per cent solution. Any redundant cyst wall is then excised and closure made. The "closed method" is usually employed in simple, nonsuppurating cysts. For complicated, suppurating cysts, marsupialization with drainage is the accepted procedure. In both procedures an additional precaution is often taken by attaching the suture line to the abdominal wall, this is the "operation of Posadas."

**Case Report**—I. B. W., a colored female, age 22 years, born in the United States, was admitted to Charity Hospital, New Orleans, November 29, 1935, complaining of an abdominal mass. She had been conscious of the growing tumor for four years, following delivery, in 1931, with dystocia or postpartum problems, at the termination of an uneventful pregnancy. The mass increased rapidly in size for a time, and according to the patient, was larger at one time than another. During the months preceding operation growth was very slow. It had, however, become sufficiently large to cause a feeling of pressure and to give discomfort, particularly when the patient stooped over to pick cotton. The patient found that pressure could be relieved by lifting the mass out of the pelvis with her hands. Her menstruation, which began at 12, was four to five days in duration with slight dysmenorrhea always, and had for the past two or three years been accompanied by some flooding; there were no other menstrual disturbances.

Except for the tumor mass, physical examination was negative. Liver, spleen, and kidneys were not palpable. The tumor mass in the lower abdomen was about the size of a six months' pregnancy, ovoid in shape, smooth in outline, freely movable, and of a semifluctuant consistency. Some pain was experienced upon deep pressure in the left flank. The vaginal examination showed the outlet to be parous, Bartholin's and Skene's glands negative. No cystocele or rectocele. There was a unilateral, well healed laceration of the left side of the cervix. The tumor mass completely filled the pelvis and was apparently intimately attached to the uterus, as no definite uterine outline could be distinguished except that portion comprising the lower uterine segment. A diagnosis of myoma of the uterus was made.

**Operation**—The abdomen was opened under ether anesthesia through a subumbilical midline incision about four inches in length. A cystic mass about the size of a large grapefruit presented itself and was easily delivered from the abdomen. This mass was attached to about one-third of the left anterior uterine wall by a sessile base approximately two inches in diameter, and the omentum was adherent to the cyst wall in one place. This adhesion was released. Both ovaries and the right tube were perfectly normal. The left tube had become attenuated and was stretched over a portion of the cyst wall to such an extent that it was difficult to identify this organ. It was quite evident that it would be impossible to remove the cyst without rupture unless a portion of the fundus of the uterus was removed. A partial fundectomy was therefore performed and the tumor in its entirety delivered without a spill. The appendix was macroscopically diseased and was removed.

Knowing that the pelvic cavity was an unusual location for such a cyst, general exploration was made in an attempt to discover a primary focus in the liver, kidneys, or spleen. The liver presented a sharp edge, was resilient to touch, with no nodula-

# ECHINOCOCCUS CYST OF THE UTERUS

tions There was a small lymph node palpable along the common duct near the foramen of Winslow Both kidneys and the spleen were similarly explored with negative findings The omentum was entirely negative except for the small adhesion to the cyst wall After operation, roentgenologic examination was made to eliminate the likelihood of the presence of echinococcus cysts in the chest and bones, with negative findings

*Pathologic Examination—Gross* The specimen revealed a large cystic mass attached to about one-third of the fundus of the uterus (Fig 1) The walls of the cyst were thickened and showed irregular sized patches of lipoid degeneration To one of these patches, a strand of omentum was strongly adherent The left tube in its proximal half was plastered to the posterior wall of the cyst by edematous inflammatory adhesions The tube was so spread out that it was almost impossible to identify it

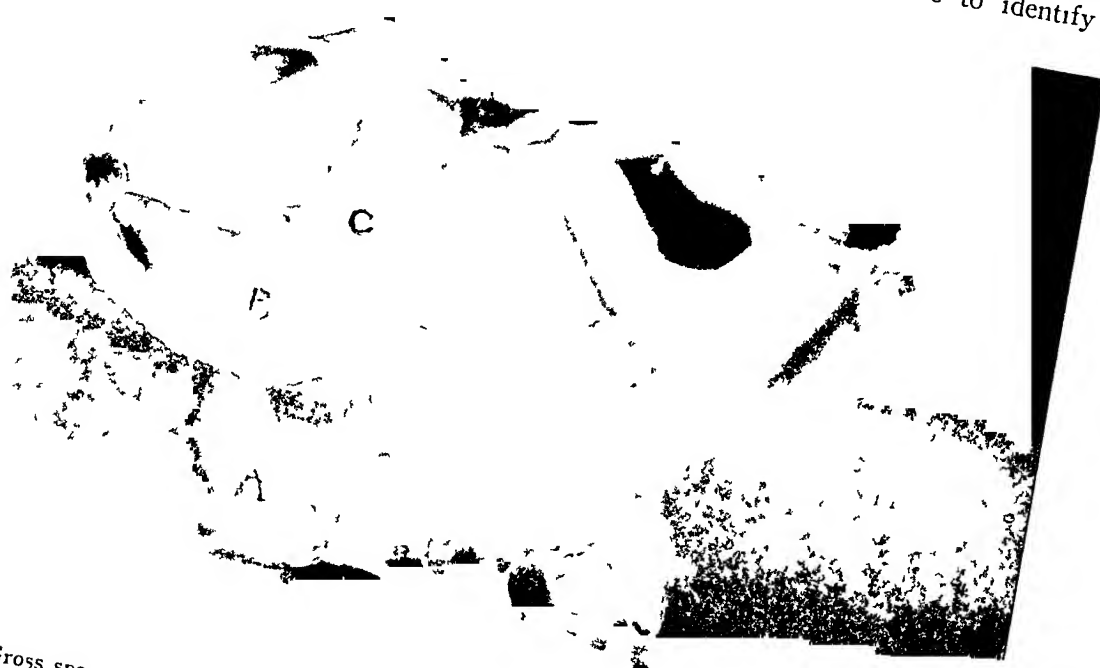


FIG 1—Gross specimen of the tumor removed (A) Fundus of uterus (B) Laminated membrane (C) Germinating layer

Dissection of the tube showed the lumen intact with no evidence of any connection with the cyst cavity An attempt was made to probe the uterine cavity to determine whether this connected with the cyst cavity No communication could be established The interstitial portion of the tube was patent, but only filiform in diameter Grossly, the cyst seemed to be arising directly from the wall of the uterus and not formed by an adhesive process The left round ligament led directly into the lateral wall of the cyst The cyst wall was about one-third to one-half centimeter in thickness, fibrous, and edematous, with yellowish lipoid patches as described previously The broad ligament was posterior and lateral to the cyst wall On incising the cyst wall, a turbid, lemon-yellow colored fluid escaped, containing numerous thin walled cysts of all sizes, ranging from that of a small bead to a large marble Many of the cysts showed thin walls and had a translucent appearance Quite a number had a hazy, grayish, thick wall The cyst cavity was lined by a thin granular, fragile, gelatinous membrane, on the inner surface of which numerous small cysts were attached Many of these attached cysts were pin point in size Smear from the cyst revealed hooklets and small cysts with activity (Figs 2 and 3)

After the operative procedure, a more detailed history was sought to determine

the definite social status of the patient and the possible source and time of her infestation. As stated, she was born in Louisiana about 20 miles north of Alexandria and had never been outside of the state. Recently, she moved about the same distance south of Alexandria, but had always lived in these two localities and had never contacted intimately an individual from outside the state. She advised that she chewed tobacco regularly and had an occasional drink of spirits. She had always lived on a farm where sheep, goats, and cows were raised and constantly had dogs as pets and lived with them intimately. When she became aware that she was pregnant, she began to eat clay, and reported that this is the custom among women in that vicinity, in the belief that certain minerals are supplied by eating clay which have a good influence on the growth of the fetus and the health of the pregnancy. Approximately a cup of clay a day was ingested, taking care to select the clay from localities where a dog had not defecated. She preferred to eat the clay in a dry state and gathered most of her supply during the dry season. However, if she had to get the clay when it was wet,

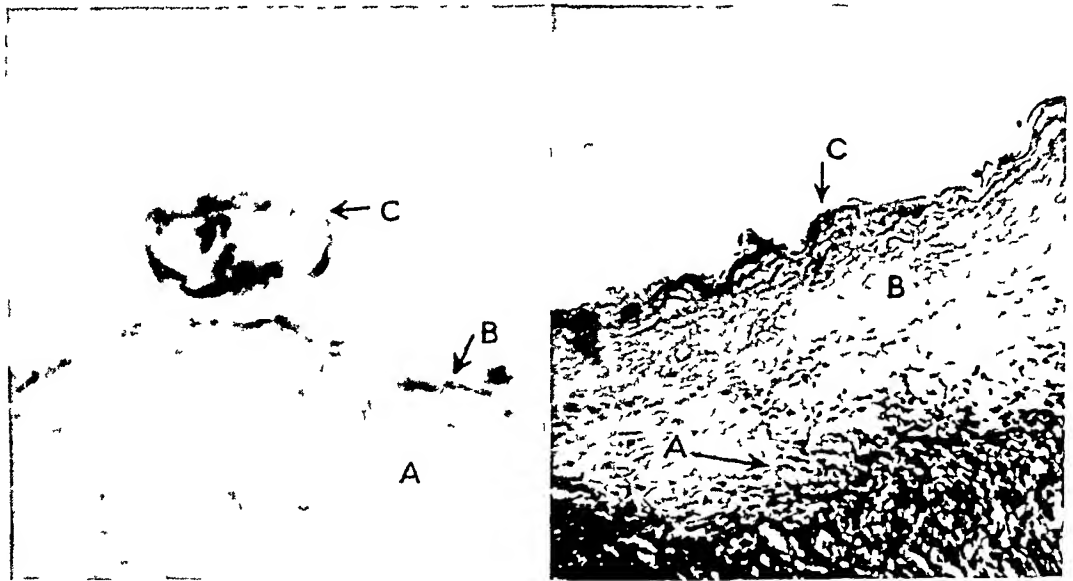


FIG 2—Section through the fundus and attached hydatid cyst wall. Myometrium (A) below and cyst wall (B) above. The greater part of the cyst wall is made up of the laminated membrane (B) which stains lightly while the germinative layer (C) is distinguished as a thin dark layer lining the wall. (Low power)

FIG 3—Portion of hydatid cyst wall. Below is the lightly staining laminated membrane (A) with the thin, darkly stained germinative (B) layer above. Free from the wall in this section is a degenerated scolex (C). (High power)

she baked it in cakes in the stove before eating it. She also reported that she formed the habit of eating paper regularly, this also included pasteboard boxes. These perverted tastes became a fixed habit with the patient and began with the inception of her first and only pregnancy, in 1931.

The patient had an uneventful convalescence and was discharged December 19, 1935. Follow up nine months postoperatively revealed that she has remained in excellent health, her only complaint being a vaginal discharge. There has been no recurrence of the cyst and no discomfort in spite of hard work at cotton picking. She has, however, discontinued the diet of clay dust and paper.

#### SUMMARY

(1) Echinococcus disease is a public health problem in many parts of the world and is more prevalent in the United States than is realized.

(2) To date, 509 cases have been reported in the literature of the United States and Canada.

(3) Pelvic echinococcus disease is rarer than that of other organs and tissues

(4) Of the cases of echinococcus cyst of the uterus reported in the literature of the United States and Canada, some are apparently erroneously classified and are in reality hydatiform moles. None of these cases is proven primary echinococcus cysts of the uterus

(5) A case of primary echinococcus cyst of the uterus is herein reported, in a native born Negress, treated by partial fundectomy, with complete recovery, and no recurrence of the cyst

#### REFERENCES

- <sup>1</sup> Davis, L., and Balboni, G. M. A Study of 29 Cases of Echinococcus Disease at the Massachusetts General Hospital. *Boston Med and Surg Jour*, 176, 726, May 24, 1917
- <sup>2</sup> Magath, Thos. Byrd. Echinococcus Disease. Etiology and Laboratory Aids to Diagnosis. *M. Clin. N. Amer.*, 5, 549, September, 1921
- <sup>3</sup> Barnett, L. E. Recent Advances in Our Knowledge of Hydatid Disease. *Surg., Gynec., and Obstet.*, 45, 148, August, 1927
- <sup>4</sup> Lyon, Irving P. A Review of Echinococcus Disease in North America. *Am. Jour. Med. Sci.*, 123, 124, 1902
- <sup>5</sup> Mills, H. W. Hydatid Cysts of the Liver, with Report of 63 Previously Unpublished Cases. *Surg., Gynec., and Obstet.*, 44, 577, May, 1927
- <sup>6</sup> Riley, Wm. A., Ph.D. Reservoirs of Echinococcus in Minnesota. *Minn. Med.*, 16, 744, December, 1933
- <sup>7</sup> Thomas, J. D. Hydatid Disease. Vol. II. A Collection of Papers on Hydatid Disease. Alfred Austin, London; Bailliere, Tindall and Cox, London, 1894
- <sup>8</sup> Beckman, Harry. Treatment in General Practice. W. B. Saunders Co., 290-291, Philadelphia, 1934
- <sup>9</sup> Stitt, E. R. Diagnostics and Treatment of Tropical Disease. P. Blakiston's Sons & Co., Philadelphia. 5 Ed. Revised
- <sup>10</sup> Mills, H. W. Hydatid Cysts of the Heart, with Report of a Case. *Surg., Gynec., and Obstet.*, 35, 455, October, 1922
- <sup>11</sup> Altormyan, A. A. Hydatid of the Uterus, Laparotomy, Recovery. *Lancet*, 1, 769, 1891
- <sup>12</sup> Cuff, Cyril H. Forty Cases of Hydatid Cyst. *Brit. Med. Jour.*, 2, 599, October 11, 1930
- <sup>13</sup> Turenne, Augusto. Primary Hydatid Cysts of the Uterus. *Surg., Gynec., and Obstet.*, 26, 446, April, 1918
- <sup>14</sup> McKechmie, R. E. A Discussion on the Incidence of Echinococcus Disease in British Columbia. *Northwest Med.*, 2, 6, 1910
- <sup>15</sup> Kerwin, W. A Case of Large Echinococcus Cyst. *Jour. Missouri Med. Assn.*, 13, 174, 1916
- <sup>16</sup> Dew, Harold R. Advances in Our Knowledge of Hydatid Disease During the Twentieth Century. *Brit. Med. Jour.*, 2, 620, October 5, 1935

# THE SHROPSHIRE SUPRAVAGINAL PLASTIC OPERATION

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DR L. S. SHROPSHIRE,<sup>1</sup> in 1914, suggested a supravaginal plastic procedure in connection with an hysterectomy, as a result of which the morbidity was greatly reduced. The method impressed me so favorably that I have operated upon a number of cases following, in the main, his technic. The results have been so uniformly favorable that I have, from time to time, adopted the principles, as set forth by him, in procedures other than that of hysterectomy, and have been convinced of its merits. It seems to me that surgeons should give it more consideration than it has received thus far. Dr H. H. Ogilvie,<sup>2</sup> of San Antonio, apparently is the only one who has as yet, reported upon the employment of this technic, and cites 119 cases with only one death. Doctor Shropshire, in his original article reported 15 cases. His communication is short enough to justify quoting it.

"I term this 'new' because as far as I know or have been able to ascertain, the method outlined has not been employed by anyone before, and it is

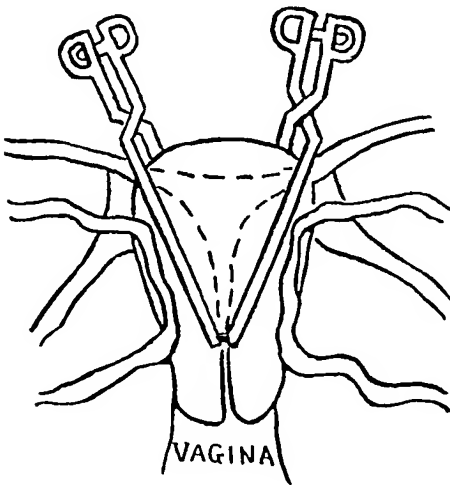


FIG. 1—Showing the clamps in place.

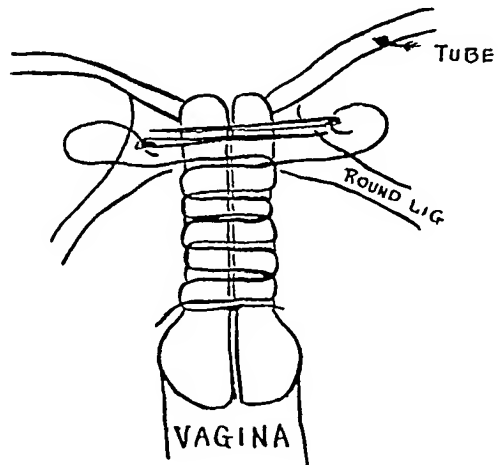


FIG. 2—Showing the saddle's stitch as applied.

distinct from the flap method, which is commonly done. For a long time I have thought that the recovery after a hysterectomy was unnecessarily prolonged, and I have arrived at the conclusion that the impingement of the nerve trunks supplying the uterus and its appendages, within the ligatures used in tying off the adnexa before their separation from the organ is largely responsible for it. To avoid this slow recovery and to prevent the many reflex disturbances which are manifest for so long a time after the operation I have devised the following method of procedure. After separating the bladder from the uterus down to the internal os, I clamp the uterus on either side from the insertion of the fallopian tube to its center at the internal os with a specially devised hysterectomy clamp, and using my



## SUPRAVAGINAL PLASTIC OPERATION

clamp as a guide, I transfix the uterus at the points of the clamps with a long sharp-pointed knife, bringing the blade out at the fundus at the inner side of the clamp, making a smooth-cut surface, then by drawing my clamps together I bring the two marginal-cut surfaces of the uterus into close apposition. With a long No. 2 chromic gut suture, with needle on either end, I begin at the points of the clamps by passing one needle between the blades of the clamp on one side and drawing the suture through to its center, then by inserting a needle from either side make a saddle's stitch until I reach the top of my flaps, when the sutures are tied securely. After this the clamps are removed and with a No. 2 chromic gut I begin at the lower end of the cut surfaces, make a deep running suture up the anterior surface over and down the posterior surface opposite the starting point. With a fine catgut suture I stitch the bladder to this stump to hold it up in its normal position.

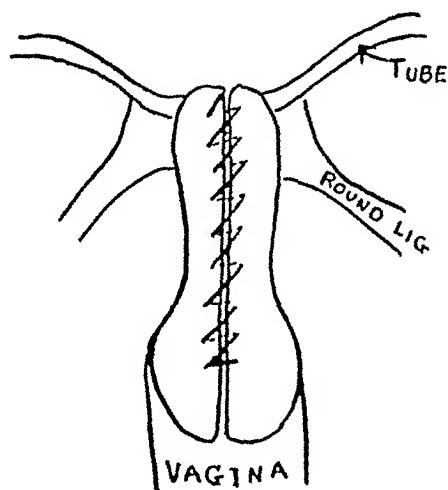


FIG. 3—Showing appearance of the stump after the running suture is introduced.

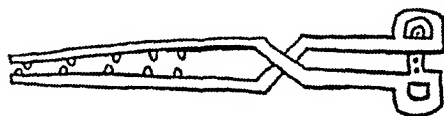


FIG. 4—Showing a specially devised clamp, with five teeth on either jaw of the clamp to prevent it from slipping off the uterus. The jaws of the clamp must be at least one inch apart at the joint.

"I deem it worth while to mention only a few of the very apparent advantages of this operation over the old method. I claim for this operation that it avoids the tying off of any nerve trunks or the destruction of any important tissues—it takes away most of the body of the uterus and all its endometrium. It is indicated in any hysterectomy except for malignant degeneration. In cases of fibroid tumor, where my especially devised clamp cannot be used, I clamp the adnexa with rubber covered clamps and proceed in a similar manner until the two segments of the uterus are securely fastened together, when the clamps are removed. In case of removal of pus tubes, I separate the tubes from the broad ligaments and apply the clamps below the tubes, removing them together with the segment of the uterus which comes away. I contend that in all cases where the function of the tubes is destroyed by pus or otherwise, this operation should be done in order to remove the accompanying diseased endometrium.

"The operation is especially applicable in all proidentias after the child-bearing period. In cases of vesicocoele, the bladder may be fastened high upon the stump and give most satisfactory results. Another great advantage is that you can retire at night without the apprehension that you may have included a ureter in tying off the uterine arteries. The work can be done in half the time it requires to do the flap operation. In this operation the uterosacral, round and broad ligaments, are drawn so tightly across the pelvis that it makes almost a perfect floor.

"I used this operation in fifteen cases, all with the most gratifying results. The first operation was done June 12th of this year, and the patient seems at the present time perfectly well, with none of those dragging pains in the pelvis and back which so often follow the old operation. In fact, in every case there has been rapid recovery."

"If this operation would meet with the approbation of the profession, and I believe it will, I will take it as a personal favor if they will let me hear from them directly."

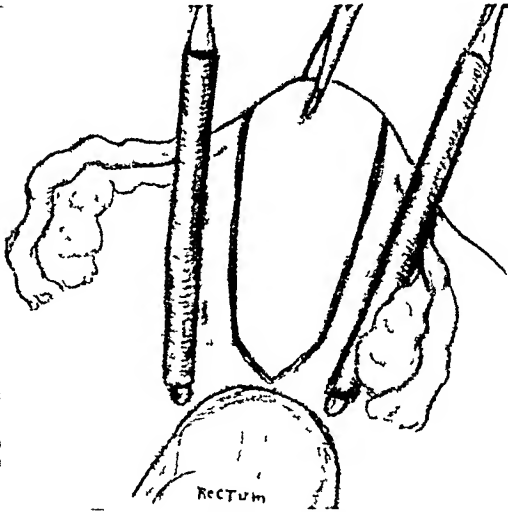


FIG 5—Supravaginal hysterectomy where tubes and ovaries are left

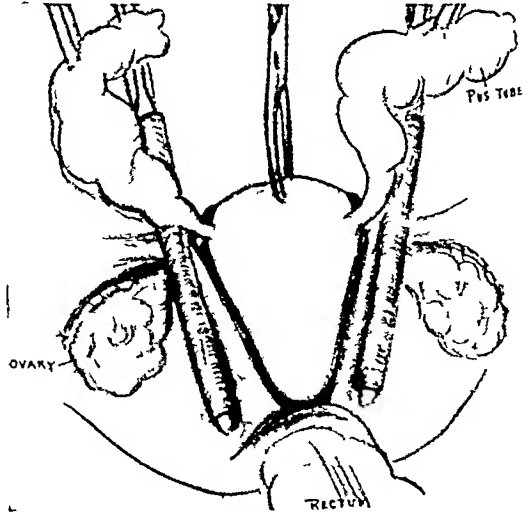


FIG 6—Shows method where tubes are removed

I desire to present the operation, discuss and propose some modifications, in order to extend the principles involved to other procedures. The operation is suitable for a number of conditions where an hysterectomy is indicated. Shropshire proposed it as a supravaginal or subtotal plastic procedure. I have proposed it as a suitable operation for removing the whole glandular part of the uterus and cervix.

I would first like to call attention, rather briefly, to the anatomy of the uterus and its blood and nerve supply. The uterine and ovarian arteries anastomose and richly supply the uterus, and while they anastomose with their fellows of the opposite side, yet the bleeding is not severe when the uterus is cut through the midline anteroposteriorly, nor is there much bleeding when a slab is cut on either side just outside the cavity of the uterus and cervix away from the midline.

The evident and fundamental reasons for the operation are that where, for any reason, the uterus is to be removed without the removal of the ovaries and tubes, the ovaries are left with their blood and nerve supply practically undisturbed. Should the fallopian tubes be diseased and their removal considered desirable, this can easily be accomplished without injuring the blood or nerve supply of the ovaries.

The operation has a very wide field of application in dealing with fibroids of the uterus where a myomectomy is not advisable, and the body of the uterus is to be removed. Shropshire used a specially designed clamp for controlling the blood supply. I have used a straight, rubber covered intestinal clamp on each side so as to better control the bleeding as the slabs are

# SUPRAVAGINAL PLASTIC OPERATION

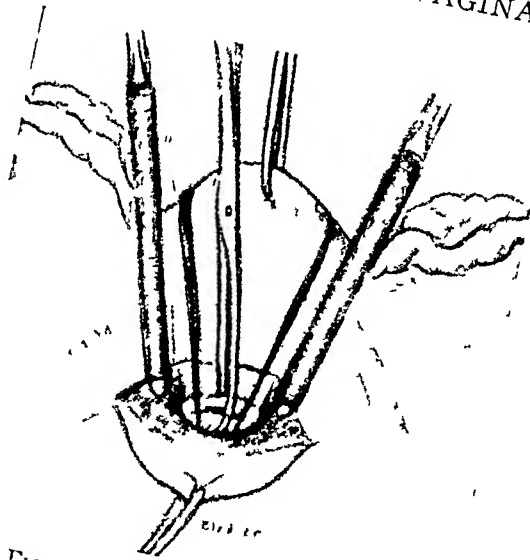


FIG 7—Panhysterectomy technic

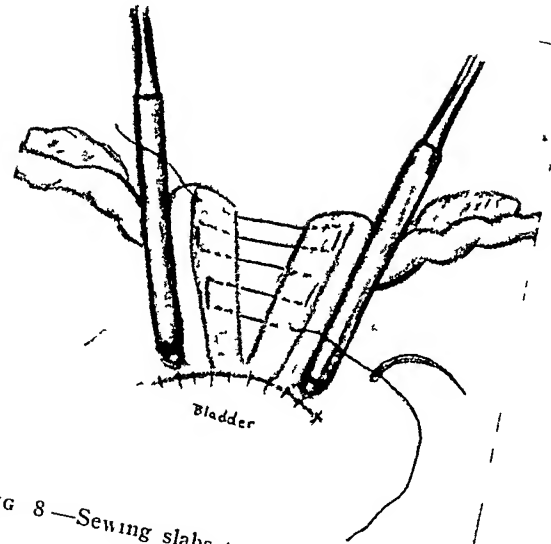


FIG 8—Sewing slabs together controlling bleeding

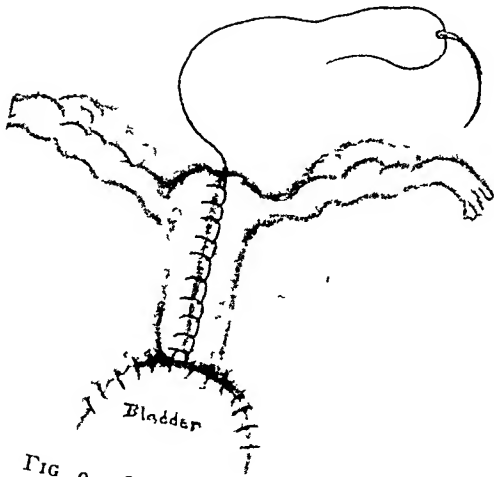


FIG 9—Closing serous surfaces

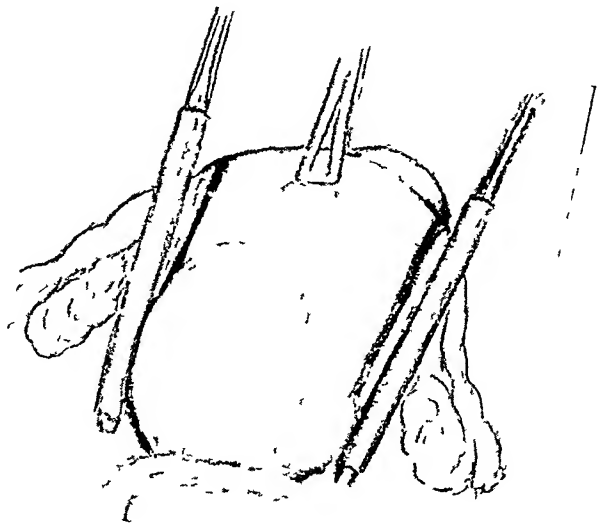


FIG 10—Method of removing a fibroid uterus

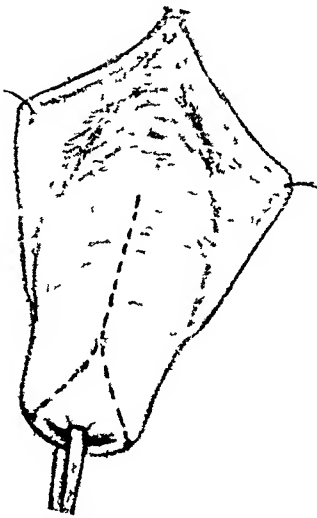


FIG 11—Suggested vaginal technic for hysterectomy or for prolapse

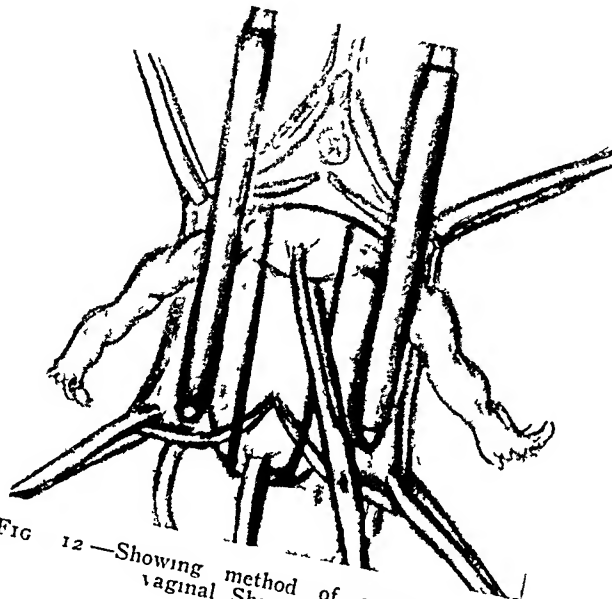


FIG 12—Showing method of performing a vaginal Shropshire

cut A few vessels may need to be individually ligated One may use the through-and-through method of the author by threading a long straight needle on either end of a No 1 chromic catgut or, as I have done in a number of cases, a curved needle may be used as shown in a mattress suture to approximate the plane surfaces of the two slabs After this the serous or peritoneal borders, anteriorly and posteriorly, are approximated with a No 1 chromic suture

I have indicated the abdominal method of performing this operation either supravaginally or where one wishes to remove the gland bearing canal of the cervix also, then the bladder is freed and pushed downward so as to expose the anterior vaginal wall This is cut through and the cervix is grasped by a volsellum or a toothed forceps and elevated so as to bring it into view The cut is now extended just outside the cervical canal, and a complete hysterectomy effected, *i e*, all of the uterine and cervical canal is removed

The approximation of the slabs is accomplished by sewing down and around the cervix after approximating the slabs by a quilting or through-and-through suture, as is done in the supravaginal operation This procedure can be carried out per vaginam in any case where the tumor is small enough to be handled through a vaginal section as has been done previously The operation is especially applicable in performing the Chauta-Watkins interposition operation for prolapse of the uterus The technic is the same as in that procedure except that the whole uterine and cervical canal is removed

The lateral slabs are handled as in the other procedures The remaining structures are now closed over by the vaginal flaps, leaving the bladder behind the much reduced mass Its advantages I think, are self-evident

In some cases where the prolapse is not too great, and the structures not too much drawn out, the removal of the central part of the fundus and cervix might correct the condition without the interposition operation

I feel that in preserving all the blood and nerve supply, a firmer union will be obtained between the slabs, and should give better results than performing an hysterectomy in the usual way and then sewing the cut ends of the ligaments together for support, as in the Mayo procedure of hysterectomy for prolapse of the uterus One not only has better structures for support, but the central gland bearing part of the uterus and cervix has been removed

The results are excellent in both of these instances—even better than when the whole body of the uterus is left, as in the ordinary Chauta-Watkins or Watkins-Wertheim technic I have never thought an hysterectomy, by any method, fundamentally sound, as a suitable operation for prolapse, as has been advocated, and have never personally employed it, although it seems to have been successful in many instances

I trust that the Shropshire operation may merit your careful consideration and trial It works!

#### REFERENCES

- <sup>1</sup> Shronshire, L L A New Supra-Vaginal Plastic Hysterectomy Tex State Jour of Med, 10, 168, August, 1914
- <sup>2</sup> Ogilvie, H H, and Shropshire, L L So West Tex Medicine, 9, November 13, 1934

# THE STATUS OF VAGINAL HYSTERECTOMY IN GYNECOLOGIC SURGERY

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A REVIEW of the recent literature on hysterectomy indicates that gynecologists are becoming more radical in removing the diseased uterus in toto. We realize that conservatism is perhaps not always the wisest course in treating a uterus which is producing definite symptoms that experience has proved are very often the forerunners of the now recognized "precancerous" conditions, and eventually of malignant changes. Gynecologists are also beginning to realize that the diseased cervix which is the source of local symptoms such as leukorrhea, pelvic pain or discomfort, and dyspareunia, can also have a marked effect on the general well-being of the patient.

We have been reassured in the last few years by the results obtained in total hysterectomies. A comparison of the mortality and morbidity in series of cases treated by these respective procedures has led to a growing belief that given the necessary skill derived from experience, and the absence of operative hazards above the average, the total operation offers advantages to the patient which overbalance the additional difficulties encountered by the surgeon. In other words, in the hands of the operator lies largely the task of conquering the dangers of total hysterectomy—the longer time needed to accomplish the operation, the greater skill required, increased difficulties in operative technic, and the greater blood loss and danger to vital organs, while the patient derives as advantages—fewer postoperative complications, smoother convalescence, and less fear of disastrous future developments, such as carcinoma of the cervical stump.

In treating conditions which require total extirpation of the uterus, the rule in most of the larger gynecologic clinics throughout the country has been to employ the abdominal route. Vaginal hysterectomy has never been popular; it is a procedure which has waxed and waned in the enthusiasm of gynecologic surgeons, and in the descent of popularity, it has even been frowned upon as an elective procedure. Wayne Babcock<sup>1</sup> inquires "Is it because it may impose operative difficulties on the surgeon? Or is it that one follows the operation to which he becomes habituated, and finds it inconvenient to select from a variety of methods when a single routine one will serve the purpose?" By way of answering this query, I fully agree with Richardson<sup>4</sup> that "Complete mastery of a satisfactory technic for total removal of the uterus by both the abdominal and vaginal routes is a minimum standard of operative skill that every gynecologist should exact of himself as early in his career as the circumstances of his period of ap-

prenticeship will permit For, unfortunately, neither of these operations is best suited to all individuals requiring hysterectomy, and superlative skill in the performance of only one of them becomes but an exhibition of poor surgical judgment and mediocre ability when applied to the correction of pathology that could be better treated by the employment of the other " If we judge that a case requires hysterectomy, our next decision should be what type is best suited to this particular case

In a series of 206 cases, private and ward, operated upon by me between August 1, 1931, and November 1, 1936, vaginal hysterectomy was selected as the most rational procedure There was but one operative death, a mortality of 0.48 per cent Follow up has been obtained on 160 of these cases, in most instances by examination at intervals, and judging from the results obtained, I feel that the choice of vaginal hysterectomy was fully justified The ages of the patients ranged from 27 to 70 years (Table I) Total abdominal hysterectomy was also performed during this same period 62 times But the advantages of vaginal hysterectomy far outweigh those of the abdominal route and its correct performance should be the aim of all gynecologic surgeons

TABLE I  
AGE GROUPS—206 CASES

27-35 years	29 cases
36-45 years	100 cases
46-55 years	56 cases
56-65 years	16 cases
66-70 years	5 cases
<hr/>	
Total	206 cases

Vaginal hysterectomy yields a lower mortality rate than either subtotal or total hysterectomy In the present series of 206 cases there was only one death At the Mayo Clinic, Masson reports that vaginal hysterectomy, when performed on the poor surgical risks for benign conditions, had a mortality of 1.7 per cent in 834 cases, which was 0.2 per cent higher than the 1.5 per cent mortality for 2,085 total abdominal hysterectomies for benign conditions performed upon those considered to be better surgical risks Many report series of vaginal hysterectomies without mortality Greenhill<sup>8</sup> reports a mortality for vaginal hysterectomy one-third of that for abdominal Heaney<sup>7</sup> cites 695 vaginal hysterectomies with but three deaths, and Wayne Babcock, 300 with no deaths

The acid test of the worth of a procedure is, however, the degree of morbidity it entails, and I think there is no one who will dispute that vaginal hysterectomy primarily submits the patient to less surgical shock than abdominal hysterectomy, and that the convalescence is thereby bound to be less stormy with fewer complications and less peril of infection The average number of days of hospitalization for the present series was 12, which in itself is indicative of a smooth postoperative period Follow up and

examination at varying intervals of 160 of the 206 cases reveal a very satisfactory result. Complete relief of symptoms in all but one case, only slight bladder symptoms remaining in two cases, dyspareunia in three cases, and slight vaginal discharge in six cases. When the symptoms of which these patients complained prior to operation are analyzed, the end-results are an encouraging testimonial to the value of vaginal hysterectomy in gynecologic surgery (Table II)

TABLE II  
SYMPTOMS—206 CASES

	No. of Cases
Leukorrhea	202
Backache	205
Urinary symptoms (incontinence, frequency, pain)	108
Vaginal bleeding, postmenopausal	24
All other types	161
Pelvic pain	79

Another advantage is the rapidity with which the vaginal removal of the uterus can be accomplished, in conjunction also with perineorrhaphy, repair of the cystocele, correction of obstetric injuries, and other surgery. The average operative time in the present series was 40 minutes (Table III)

TABLE III  
OPERATIONS

Vaginal hysterectomy	20
Vaginal hysterectomy and perineorrhaphy	186
Complete tear operation	2
Salpingo-oophorectomy	7

In this series, vaginal hysterectomy was chosen (1) To extirpate a diseased uterus and cervix, and (2) As an incidental procedure to correct a complete prolapse of the uterus and vagina.

I believe, in dealing with a diseased uterus and its more diseased cervix—conditions which are usually accompanied by menstrual disturbances and pelvic pain—that more radical therapy than we have employed in the past is imperative. Our hope that the endocrines would solve our difficulties in controlling bleeding from an otherwise healthy uterus has not been realized, and our greater fear of the development of malignancy in a diseased uterus has led us to the adoption of this more radical procedure. If we can prepare our patients and master a technic which reduces the mortality and morbidity to a negligible factor, then we should advocate the performance of hysterectomy more often, and in the absence of extensive inflammatory conditions of the pelvis and very large fibroids, we should usually perform the operation through the vagina.

The first indication for which vaginal hysterectomy was performed in this series, *i e*, a diseased uterus, included cases of fibroids not larger than a three months' pregnancy, early malignancies of the cervix and corpus,

fibrosis of the uterus, menopausal bleeding, all associated with a very badly diseased cervix. In all these cases there was, of course, a certain amount of prolapse, cystocele, and relaxation of the pelvic floor. It would seem that in women at or near the menopause, complaining of pelvic pain, vaginal bleeding and discharge, with an enlarged fibrotic uterus, chronically diseased cervix, cystocele, and lacerated perineum, where a fair degree of prolapse exists, that a total removal of the uterus from below with correction of the cystocele and rectocele, is a logical and indicated procedure.

Former treatment of chronic cervicitis by local measures—cauterization, partial amputation, diathermy, and more recently conization—has often not given the patient the relief she desires. While I do not attempt to discredit these forms of treatment for the diseased cervix when the pathologic changes are confined to the cervix, or when the symptoms are strictly local, however, when the infection has extended beyond the cervix, and when the symptoms point to disease also in the body of the uterus, and the parametrium, or when the condition is producing systemic changes such as loss of weight or anemia, and is a definite focus of infection, I believe that the more radical treatment is indicated. Conservative plastic operations, cauterizations, and conizations often result in stenosis of the cervix, which is the cause of changes leading to a train of symptoms eventually requiring extirpation of the entire uterus (Table IV).

TABLE IV

## PATHOLOGIC CONDITIONS FOR WHICH VAGINAL HYSTERECTOMY WAS PERFORMED

CERVIX	No. of Cases	UTERUS	No. of Cases
Diseased cervix	187	Fibroids	38
Lacerations	138	Fibrosis	148
Erosions	46	Pyometra	4
Stenosis	19	Atrophied	16
Polyp	5	Procidentia	43
Suspected malignancy	17	Cystocele	190
Previous amputation	8	Lacerated perineum or rectocele	206

In extensive cystocele associated with procidentia, repair of the cystocele by replacing the uterus and reconstructing the fascial supports will not suffice, as the weight of the uterus will often cause a recurrence. We must not lose sight of the fact that in procidentia the condition is not altogether due to the failure of anterior supports of anterior fascia, but to the failure of posterior supports as well. Therefore, some form of shortening the entire broad ligament is necessary and not merely shortening of one or more of its component parts. This can be effected only by shortening the broad ligaments at their midportion, which necessitates removal of the uterus, be it diseased or not. This step enables us to shorten the broad ligament and thereby construct a satisfactory sling or support for the replaced bladder. In the great majority of cases of procidentia, the patient has long passed the period when the uterus is a functioning organ, and



therefore its removal is only an incidental procedure, but one that is necessary if we are properly to correct this always distressing condition

In this series there was only one case in which the operation did not bring about the desired results, and which, therefore, might be considered as a failure. In all the others the patients evidenced satisfaction at the general improvement in health and in the cure of distressing symptoms

#### CONCLUSION

I think, therefore, that vaginal hysterectomy has a valuable place in gynecologic surgery as a procedure offering many advantages, and believe that an analytic consideration of its usefulness has often been overlooked in the past. I am of the opinion that there are, at times, definite indications for its election over any other procedure, and am further of the opinion that the results obtained in these selected cases offer adequate and convincing testimony in support of this conclusion

#### REFERENCES

- <sup>1</sup> Babcock, Wayne W. A Technique for Vaginal Hysterectomy. *Surg., Gynec. & Obstet.*, 54, 193, February, 1932
- <sup>2</sup> Barr, Richard A. Hysterectomy. *Tr. Sou. Surg. Assn.*, 48, 206, 1935
- <sup>3</sup> Bryan, Worcester A., and Trabue, Chas. C. Total Hysterectomy. *Tr. Sou. Surg. Assn.*, 48, 216, 1935
- <sup>4</sup> Richardson, Edw. H. Total Hysterectomy by the Abdominal Versus the Vaginal Route in Benign Uterine Disease. *Am. J. Obstet. & Gynec.*, 32, 641, October, 1936
- <sup>5</sup> Goodall, J. R. Total Versus Subtotal Hysterectomy. *Am. J. Obstet. & Gynec.*, 32, 629, October, 1936
- <sup>6</sup> Tyrone, Curtis H. Vaginal Hysterectomy. Its Indications, Technic and End-Results. *New Orleans M. & S. J.*, 88, 490, February, 1936
- <sup>7</sup> Heaney, N. S. Series of 627 Vaginal Hysterectomies Performed for Benign Disease with three Deaths. *Am. J. Obstet. & Gynec.*, 30, 269, August, 1935
- <sup>8</sup> Greenhill, J. P. A Study of the Deaths Following 6,022 Gynecologic Operations. *Am. J. Obstet. & Gynec.*, 24, 183, August, 1932

#### DISCUSSION OF THE PAPERS OF DOCTORS BURCH, MILLER, MOORE, AND TYRONE

DR. JOHN W. PRICE, JR. (Louisville, Ky.)—This is a very interesting group of gynecologic papers. Relative to Doctor Burch's paper on perineorrhaphy, I think he has developed an excellent operation and satisfactorily demonstrated how he dissected the fascia and sutured it properly. The operation we perform is not complicated by the variety of sutures he showed. We do what I have always chosen to regard as a modification of the Mayo flap splitting operation. We have been using it for a good many years. The essential step is to expose the levator ani and employ a continuous button-hole suture, which practically always controls any hemorrhage. It has been noted that if one does not enter the fascia of the levator ani, bleeding seldom occurs.

Regarding Doctor Moore's type of hysterectomy, which I would regard as a subtotal hysterectomy on account of the large amount of the wall of the uterus he leaves behind, the only criticism I would offer is that in cases of fibroid tumor of the uterus it would be possible that some small fibroid which was unseen at the operation would remain in the wall and would subsequently grow and have to be removed. In my work I have been un-

fortunate enough to have fibroids develop in the remaining stump of the cervix following subtotal hysterectomy, and I have operated upon some cases for the same condition where the patient had been previously operated upon in other clinics. In my own practice the incidence of fibroid occurring in the stump of the cervix has not been frequent but other men have reported these cases in considerable numbers.

Regarding Doctor Tyrone's advocacy of vaginal hysterectomy, I think he is correct in stating that these patients do have less shock. I have limited vaginal hysterectomy to that group in which I thought it was particularly indicated, using it rather more in elderly women. Formerly women in the neighborhood of 40 were included in this category, but I think the age should be raised to 50 or 60 to make the vaginal type proper for "elderly" women. I do not like to perform a vaginal hysterectomy if I think there are many adhesions in the abdomen. In the group we have in the City Hospital, with the complications of cystic ovaries, *etc.*, I prefer going in supravaginally. In the cases with complete prolapse where the uterus slips around like a ball on the end of a string I think a more rapid operation such as the one Doctor Tyrone described is more desirable.

DR ROBERT L PAYNE (Norfolk, Va.) —I enjoyed Doctor Buich's presentation of the operation he has developed for perineorrhaphy, and while I presume that support must be provided, I think the real promise is that we are dealing with a definite hernia in the rectocele. I do not think that the separation of the levator ani on the sides only, as shown in Doctor Buich's drawings and technic, is quite sufficient. I think the rectocele must be freed in its entirety, just like an hernial sac, all around, and when you have done that you can reduce the sac and push it down and you will have more levator ani for closure, which does not obtain when the other procedure is carried out with only the lateral sides of the rectocele freed from the levator ani.

To demonstrate what I mean. Instead of freeing the levator ani only in a vertical way and trying to bring that across, it should be freed all around and the rectocele reduced, which will leave at least half an inch more of the levator ani for closure over the rectocele. (Ref. JAMA, 78, 574, February 25, 1922.)

Doctor Tyrone's paper interests me immensely. I congratulate him upon his splendid results, but there is a complication of vaginal hysterectomy—namely, genital prolapse—that he did not touch upon, which I consider very important. When vaginal hysterectomy is performed by a competent surgeon, prolapse of the bladder and the vagina afterwards is a very rare occurrence. Frequently, however, this operation is performed by an incompetent operator, and then complete genital prolapse of the bladder and vagina, not infrequently, takes place. I encountered this unusual condition several years ago, and could find no operative method of handling the problem in the literature. The problem was apparently solved by a method I developed, which was published in the Arch Surg, 20, 637, April, 1930. We successfully have operated upon four cases with this condition. Fourteen other instances, which have been operated upon by other surgeons, employing the same technic, have been reported to me, with successful results being obtained in each case. It is of course highly essential that a very snug perineal repair be effected in addition to the intra-abdominal technic.

DR R H JACKSON (Madison, Wis.) —I wish to thank Doctor Moore for his explanation of the smoothness with which patients convalesce after this type of operation. The name which I have used to designate it is sub-

cortical vaginal hysterectomy My technic is a little different from that described by Doctor Moore, but achieves the same end, so that crushing injury to the broad ligaments is avoided After the fundus uteri is freely mobilized in the vagina, a tenaculum is applied at a point just below the summit of the fundus on its posterior surface, another tenaculum is applied on the anterior surface of the fundus an inch below its summit Rubber covered bayonet clamps are applied to the broad ligaments sufficiently tightly to control the arterial supply (not crush the tissues) With the scalpel or radio knife, two incisions are started just below the upper tenaculum and pass in concave curves over the fundus to just within the attachment of the round ligaments, and thence turn slightly downward and meet at a point behind the cervical os With careful deepening of these incisions from above downward, leaving a uterine shell approximately one-eighth inch in thickness, the uterine body with its mucous membrane cavity intact is removed, save for the above mentioned cortex or shell All visible vessel ends are ligated, the control forceps unlocked, and all bleeding points secured A single No 2 chromic catgut suture is placed at the site of the tenaculum—the ends being left ten inches long to serve as the anchoring “crown suture” under the pelvic arch The uterine shell is then reduced to approximately the size and shape of a finger by interrupted or spiral sutures and then anchored by the “crown suture” The lateral reduction gained by thus approximating the points of origin of the round ligaments tightens the broad ligaments very satisfactorily, and this, together with the “crown suture” and the insertion of a uterosacral ligament suture at the opposite end, insures an excellent pelvic floor The operation is completed in the usual way by overlapping the inelastic layer of fascia as in the Mayo umbilical hernia operation In my experience with this operation during the past 25 years, it presents certain advantageous features

- (1) There are no raw surfaces left in the peritoneal cavity
- (2) There is less danger of thrombosis and possible embolism
- (3) There is less danger of sloughing in the vaginal vault which sometimes accompanies the multiligatured and sutured, crushing clamp-broad ligament procedure

(4) In well over 100 such operations, there has been no known instance of recurrence of cystocele or prolapse

(5) Convalescence is definitely smoother, due possibly to the gentler handling of the tissues and the avoidance of injury to the nerve structures, as pointed out by Doctor Moore in the Shropshire operation

(6) Another advantage, possibly a small one, but psychologically of value, is that of being able to tell the patients that all of the womb was not removed They feel less unsexed

Naturally one would not use this method in a uterus well peppered with small fibroids on the posterior fundal wall Preferably, it is used in elderly patients with prolapse and cystocele, the remaining cortical uterine body being used as in the Watkins' interposition operation

DR WILLIAM T BLACK (Memphis, Tenn) —The technic Doctor Burch has given us is splendid However, I think in operating we all use different types of technic in nearly every perineorrhaphy We cannot follow the same one in all cases It is necessary to have a very free dissection I have seen apparently perfect perineorrhaphies in women, who had lateral lacerations of the vagina, that had to be reoperated upon

I think we should thank Doctor Miller for presenting the subject of

echinococcal disease of the uterus so that we may look out for such cases in the future

Doctor Mooie's exposition seems to me to be more of an incomplete rather than a complete supravaginal hysterectomy. It may be all right, but I believe it better to remove the entire body of the uterus. If we save uterine tissue, it is better, I think, to save the endometrial portion of the uterus, so as to preserve menstruation and prevent psychoses. However, I do not advise this in the usual case requiring a supravaginal hysterectomy.

In my opinion, Doctor Tyrone is correct in saying that vaginal hysterectomy is an overlooked operative procedure. Certainly for those patients who have indications for such an operation, it is ideal. It is particularly suited to elderly women who are obese. You can perform it under local anesthesia (if necessary) and there are practically no postoperative complications. I think in fibroid tumors of any size the supravaginal route is the best. In 57 per cent of the cases of fibroids noted in the records of John Gaston Hospital, chronic inflammatory pelvic disease was concomitant, which would preclude a vaginal hysterectomy. Certainly we should have complete vaginal relaxation. It is suitable in cases with a large cystocele and rectocele accompanied by procidentia. In cases of vaginal prolapse following a vaginal hysterectomy referred to by the speaker, fixation of the vagina to the abdominal wall, in rare cases, gives a splendid result. I described such a case several years ago, which was abstracted and published in the Year Book of Obstetrics and Gynecology, but have not had an occasion to use the method often since. If one will take pains in bringing the round and broad ligaments, and also the sacro-uterine ligaments together, you get a very good support. Permanent sutures to the pubic fascia from the above structures and taking pains in grasping the para-uterine and paravaginal fascia will usually prevent a vaginal hernia.

DR C J HUNT (Kansas City, Mo.)—I wish to say a few words in behalf of the value of vaginal hysterectomy for a selected group of cases who are past the menopause or advanced in years and have a grade three or four prolapse of the uterus accompanied by cystocele and rectocele. Vaginal hysterectomy in this group of cases eliminates the prolapsed uterus, prevents a possible future malignancy of it, and affords ample approach for the repair of the cystocele.

Two cardinal principles are essential in the operation of vaginal hysterectomy for uterine prolapse with cystocele. In the repair of the pelvic floor after hysterectomy, the broad ligaments are sutured together in the midline, and on each side of the urethra they are securely anchored to the pubic fascia. This prevents future prolapse of the bladder over the broad ligaments. In addition, it is necessary to obliterate the cul-de-sac by a suture which picks up along with the uterosacral ligaments the peritoneum on each side and between. This prevents future culdesac herniation.

In the repair, one must keep in mind the anatomy of the pelvic floor and remember that the prolapsed condition is simply that of herniation through faulty support. The pelvic diaphragm is chiefly made up of the levator ani muscle and the pelvic fascia. The muscle converges from its origin along the under surface of the pubic ramus, obturator fascia and ischial spine toward the midline uniting in a median raphe. The fascia is very definite and at points where support is needed it becomes thicker and stronger, as illustrated by the vesicovaginal fascia, the fascia around the hiatus uteri and the rectovaginal fascia. When the continuity of these structures is broken there is an herniation of the organs they support, therefore, a repair of vesicocele

consists in the repair of the fascia through which the bladder has herniated

The same applies to the reconstruction of the vaginal floor. The uterus prolapses when the supporting structures have been weakened and when it assumes the retroverted position. The uterus to prolapse must be in the same axis as the vagina, a retroverted position. Intra-abdominal pressure and posture then aid in the descent. When the anterior position of the uterus is maintained the antiflexion is increased by intra-abdominal pressure and there often occurs an elongation of the cervix. The effects are in direct relation to the degree of pelvic floor defect and the anatomic position of the uterus.

I have been especially interested in repair of pelvic floor defects and have followed very closely the methods and principles so well emphasized by Dr. J. C. Masson. The results in the type of case that I have discussed have been very satisfactory.

DR. F. WEBB GRIMMITH (Asheville, N. C.)—I would like to ask Doctor Moore to tell us a little more about his vaginal hysterectomy. Wherein is it superior to the Mayo operation? In short, what does he hope to accomplish that the Mayo operation will not do?

I was interested in Doctor Tyrone's paper, for I am sure we are not doing enough vaginal hysterectomies. One reason is that most of the gynecology in the smaller towns is done by general surgeons who have not had special training in gynecology, and frequently they do not know how to perform a vaginal hysterectomy safely and satisfactorily. That, however, is not the only reason. It was my privilege to spend nearly five years on the gynecologic staff of one of our well known hospitals. In that period I am sure I did not see over two dozen vaginal hysterectomies. It is true that was 25 years ago, but I understand that the ratio of vaginal to abdominal hysterectomies in that institution is still very low. Possibly the explanation is since the gynecologists there do such excellent "abdominal gynecology," they do not often feel the need of doing an hysterectomy per vaginam.

Regarding Doctor Payne's remarks, I do not see how you can get much worse cystoceles than sometimes follow an abdominal hysterectomy for marked uterine prolapse. There is no stereotyped operation for these distressing cystoceles. A rather extensive denudation of the vaginal portion of the bladder and closing over as in the ordinary cystocele operation, followed by a thorough perineorrhaphy, almost to the occlusion of the vagina, offers the best prospect for cure, or at least of benefit. It may, or may not, be necessary to follow that by laparotomy, tacking up the bladder to the abdominal peritoneum, and also placing sutures here and there to any of the remaining pelvic structures, which might help to hold up the bladder.

DR. JOSEPH E. J. KING (New York, N. Y.)—I have enjoyed these papers very much, but I had hoped that Doctor Miller's consideration of echinococcal disease in general would offer an opportunity in the discussion for someone to say something about extirpation of echinococcal cysts of the liver rather than marsupialization.

In 1926, I reported a case of complete extirpation of an echinococcal cyst of the liver. It projected from the lower border of the liver, was about the shape and size of an eggplant, and was surrounded by a considerable amount of fibrous tissue. This permitted complete extirpation, leaving a horseshoe-shaped defect in the lower portion of the liver. It was quite simple and easy, and the patient made an uneventful recovery.

This contrasted markedly with two other cases which I have observed,

and in which marsupialization was employed. These wounds persist for a long time and are dirty and slow in healing. Complete extirpation, when this can be effected, is advised.

DR JOHN C BURCH (closing) —Each rectocele must be treated according to its own particular needs. The method of dissection described in the paper permits of this individualization.

DR CURTIS H TYRONE (closing) —I wish to thank the Fellows for their discussion. I did not mention drainage, but when I first began the work I drained some of the cases and found no difference in convalescence in the cases that were drained and those that were not.

As to the problem of prolapse of the vagina that Doctor Payne brought up, I have seen that following every type of hysterectomy, and it is a very distressing condition. This condition has not developed in any case that follow ups were obtained on in this series of cases.

I can recall assisting the late Dr C Jeff Miller in operating upon several cases of vaginal prolapse following hysterectomy done elsewhere, and he always repaired the prolapse by a vaginal operation with excellent results.

The reason I am advocating vaginal hysterectomy is because one can correct the obstetric injuries and better prevent the development of this condition than by abdominal hysterectomy.

DR JOHN T MOORE (closing) —I wish to thank Doctor Jackson for giving me a little help. It looked as if I nearly batted out on this operation of Doctor Shropshire's. It would take me too long to say everything that has come into my mind to say while this discussion has been going on. I have not touched on many of the things that have been brought out in the discussion. I admit that all lacerations should be repaired when performing this operation. Every woman should be completely operated upon, if possible. We keep in mind, however, the so called "shot gun" treatment, the basis of which is that if you do not do any good for the patient you should do no harm. If one reads the literature I think he will come to my conclusion, that the uterus has more function than that of bearing children. I am not wedded to any particular treatment. This is not my baby, it is a baby I have adopted but I think there is more virtue in it than has been accorded it. One important thing is that with the average clamp applied to the tissues and a ligature placed on the vessels you have danger of a thrombus. If you can get away from that danger it would be well to do so. You understand these slabs can be cut away without much hemorrhage, and the blood and nerve supply are but little disturbed. A supravaginal hysterectomy is easier to perform than a total hysterectomy, and I believe that the difference in mortality in "occasional surgery" will overcome the  $\frac{1}{2}$  to 1 per cent of cancer shown to occur in the cervixes left behind. This technic will reduce the death rate by the usual procedure of hysterectomy. So I believe a supravaginal hysterectomy will leave a higher percentage of patients alive and well than will the complete hysterectomy. It is better for the surgeon to select his cases. I do not perform a complete hysterectomy all the time, sometimes I prefer a vaginal hysterectomy. I try to have an appreciation of the danger of carcinoma in all cases. I can perform a complete hysterectomy better by this method than I can by the other. If you are not too wedded to any particular type of operation, I think you will try this procedure and will find the results are better. In employing it you do not interrupt any important nerve trunks—only the small twigs. In this plastic method you conserve the complete blood supply.

## VAGINAL HYSTERECTOMY

to the ovary and the slabs That is, you have preserved the most essential circulation The idea of leaving a part of the uterus in which a fibroid may develop is possible, I admit But I have a sense of touch which I think will detect any fibroid as small as a mustard seed All of us can cultivate that type of touch if we try Good strategy is to always leave yourself where you can get out if the other fellow licks you, and it is a good plan to perform an operation in such away that you can change the type of procedure if it is necessary

Doctor Payne spoke of a fixation operation I was talking about the interposition operation—the Chauta-Watkins type I would not advocate using this type altogether in procidentia, but I think you can get a better result from this modified procedure than by any other I know of I have had occasion to look up every technic that is mentioned anywhere Doctor Shropshire mentioned the preservation of the nerve supply complete in his procedure and very little interference with the blood supply If you have a procidentia to deal with you must consider the case and adopt the technic most suitable for that case I have seen people perform hysterectomies where the whole bladder and uterus were coming down and even out I admit the excellent work of Dr Charles H Mayo, and with all the vessels tied and the structures brought close together you may get a very good result, but not so good as you do with these slabs left as a support, with part of the uterus left behind with their complete blood and nerve supply to the ovaries Then function is carried on by giving their usual endocrine supply I accept this interposition operation as a standard method, in the hands of the best gynecologists in the country, of curing severe prolapse and of the cervix, sewing these slabs together and leaving a smaller body interposed Doctor Jackson illustrated this but in a different technic The body of the uterus is not sewed to the abdominal wall but puts the bladder behind the uterus The best type of repair must be given in each case In my first paper before this Association I presented a method of curing prolapses of the uterus Doctor Watkins of Chicago thought his interposition operation solved the problem in all these cases I think the Chauta-Watkins operation a good one in suitable cases, but I use other methods at times

I like the technic Doctor Burch has shown us and I believe he will get good results It is an excellent operation, but a man who hunts squirrels in the woods where there are lions and tigers must carry not only a squirrel gun but one for lions and tigers



## A SATISFACTORY METHOD OF REPAIRING CRUCIAL LIGAMENTS

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RUPTURE of the crucial ligaments is a severe injury, and with the increasing number of automobile, industrial, and football injuries, is becoming more frequent. Rupture of the posterior crucial ligament is probably more rare than rupture of the anterior.

If, after an injury to the knee joint, the tibia can be displaced backward or forward or rotated inward in the extended position, injury to the crucial ligaments is diagnosed. If, in the extended position, the tibia cannot be displaced forward, the anterior crucial ligament is not ruptured. If, in full flexion, the tibia cannot be displaced backward, the posterior crucial ligament is not ruptured, or, in other words, in anterior displacement of the tibia with the knee extended, you have a rupture of the anterior crucial ligament, and if the tibia can be displaced backward with the knee flexed, the posterior crucial ligament is ruptured.

All of these crucial ligament injuries should first be treated by prolonged immobilization of the knee joint—three or four months—and the conservative treatment given a fair trial before operation is resorted to.

Suture of the ruptured crucial ligaments is a rather difficult procedure, and it is practically always necessary to resort to some type of reconstruction operation to repair them. Such operations have been devised and reported by V. Putti, Haygroves, Alwyn Smith and others.

I wish to present an operation which has given good results in my hands, and which I feel will work equally well in either rupture of the anterior or posterior crucial ligament. Some of the cases which I have seen have a relaxation of the capsule of the knee joint, and, in my opinion, the capsule of the knee joint should always be tightened anteriorly at the time of the operation. I prefer to use the fascia lata in repair of the crucial ligaments, and feel that a very liberal strip of fascia should be used so that when the fascia lata is folded or rolled together, it should be the size of a lead pencil or the little finger in order to give greater strength. I also believe that the strip of fascia lata should be long enough to pass through the joint and out below the capsule, then externally over the capsule, to be fastened finally to the site of entrance of the fascia lata in the femur, thus forming a complete loop and further strengthening the joint.

I believe also that the fascia lata should enter the femur above the condyle instead of through the condyle, also that the fascia lata should enter the knee joint in the center of the intercondylar notch, and pass through the tibia just anterior to the tibial spines, and make its exit from the tibia just



anterior to, and below, the head and neck of the fibula. The above points, in my opinion, are very important, and if they are followed, the operation described below will give good results.

**OPERATIVE TECHNIC**—A long incision is made over the external surface of the thigh, extending from just above the knee joint involved well up on the thigh to allow for a good long liberal strip of fascia lata (Figs 1 and 2). The defect in the fascia lata caused by removing this strip of fascia is then closed with chromic gut No. 2. This leaves the lower end of the fascial strip free at the upper end and still attached near the knee joint (Fig. 2). The knee joint is then opened through a split patellar incision and inspected (Figs 3 and 4). The muscles above the external condyle of the femur are then separated by blunt dissection down to the bone, held aside by blunt

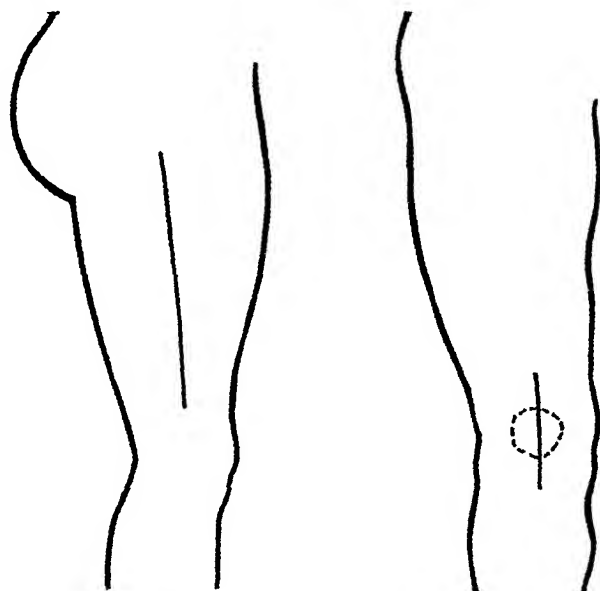


FIG. 1—Shows the position of the lateral incision on the thigh for the removal of fascia lata, also the location of the split patella incision.

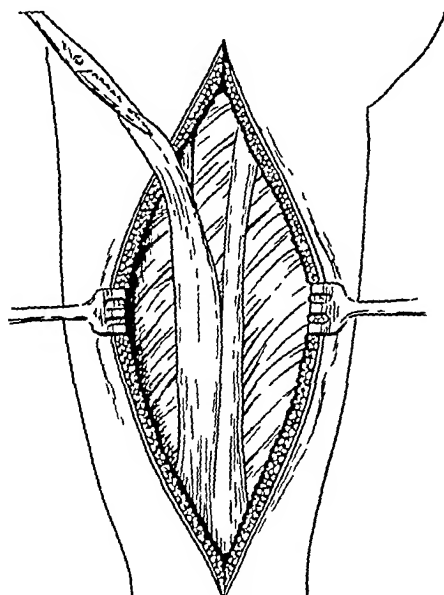


FIG. 2—Indicates the removal of the strip of fascia lata.

retractors, and a drill about the size of a lead pencil is passed through the femur from a point above the external condyle of the femur to the middle of the intercondylar notch. Then, with the knee flexed to a right-angle and the knee joint open, the same drill is passed from a point just anterior to the tibial spines in the direction of a point on the tibia just below the capsule of the knee and slightly anterior to the neck and head of the fibula. In some instances where it is not possible to obtain the proper angle with the drill from above, it is necessary to make the openings communicate in the tibia below through another drill hole in the position mentioned (Figs 5 and 6).

We are now ready to pass the strip of fascia through the holes in the femur and tibia. To do this, I prefer a suitable length of phospho-bronze wire doubled on itself, the strip of fascia being passed through the looped end. The strip of fascia is now pulled through the knee joint fairly snugly, with the knee extended. The split patellar incision is now closed, tightening the joint capsule as much as is thought necessary. If there is much relaxation, it may be necessary to remove a small portion of the patella. The capsule

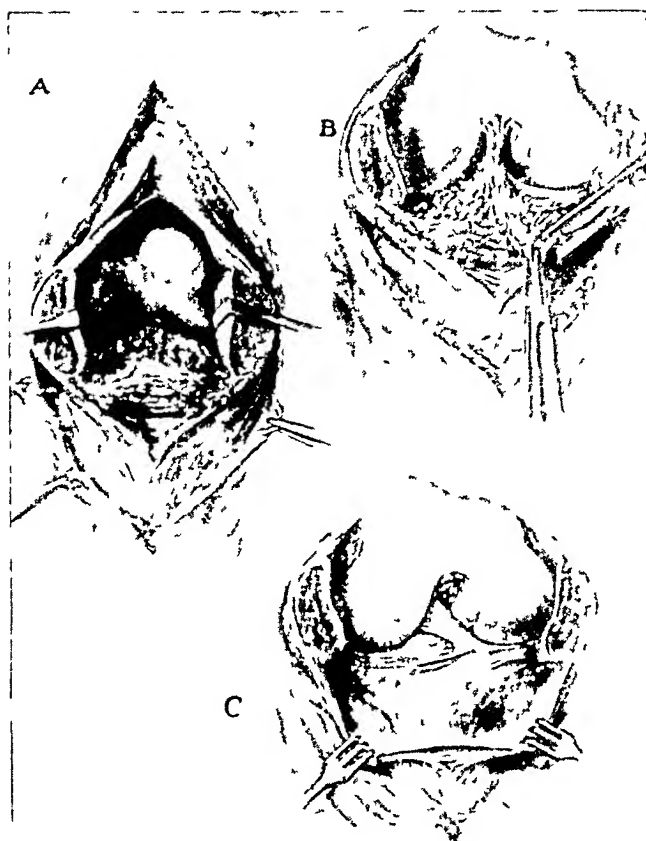


FIG 3—Demonstrates the split patella incision, with the exposure of crucial ligaments and condyles of the femur

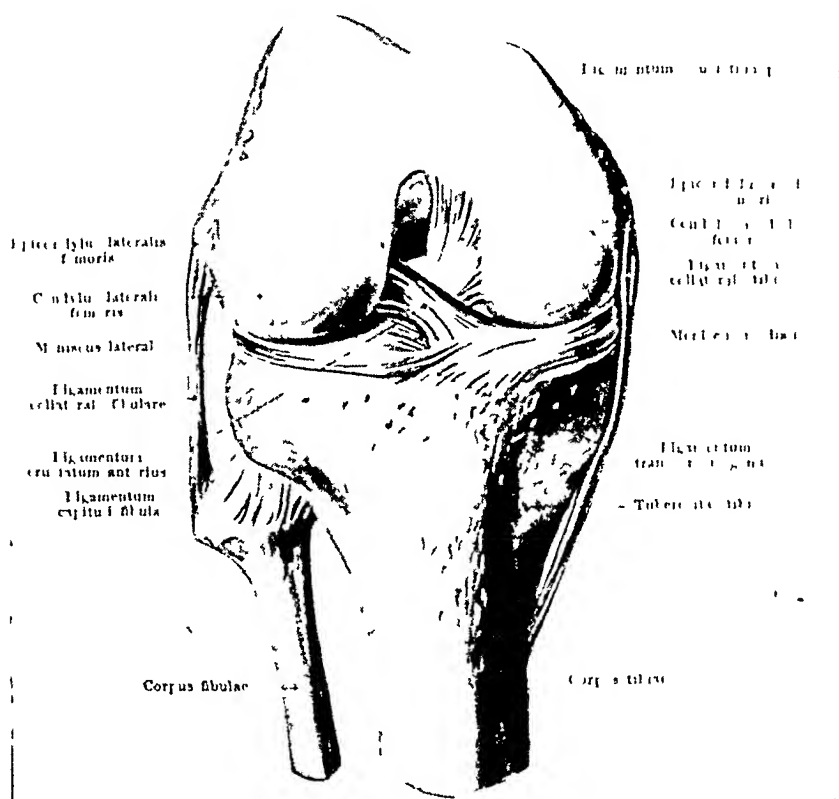


FIG 4—An anatomic cut demonstrating the crucial and other ligaments of the knee joint

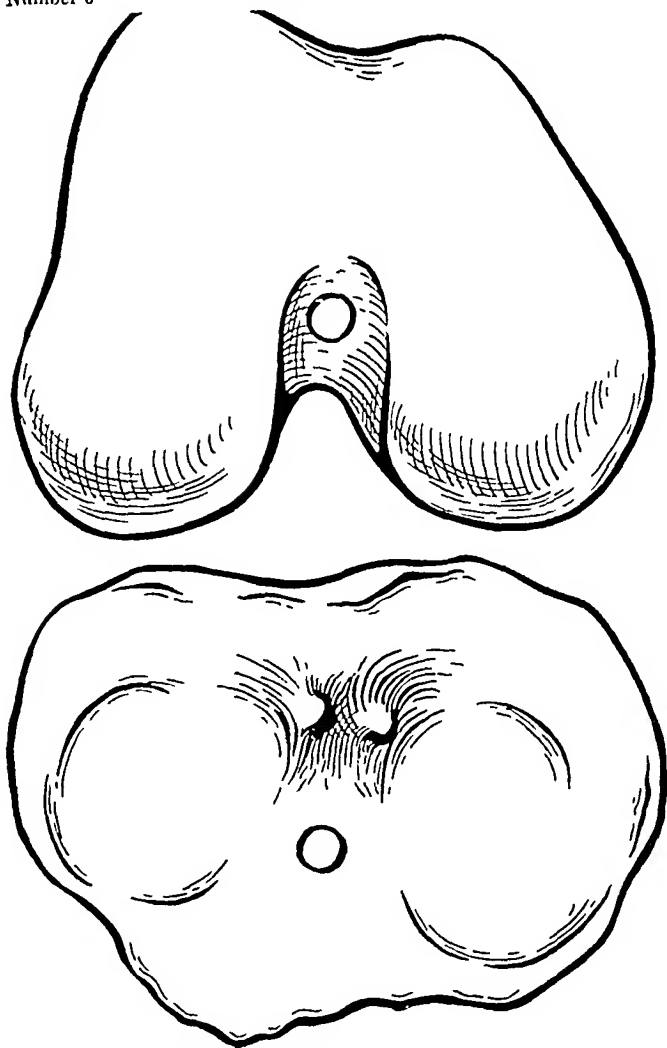


FIG 5—Indicates the position of the holes bored in the femur and tibia as near the center of the joint as possible

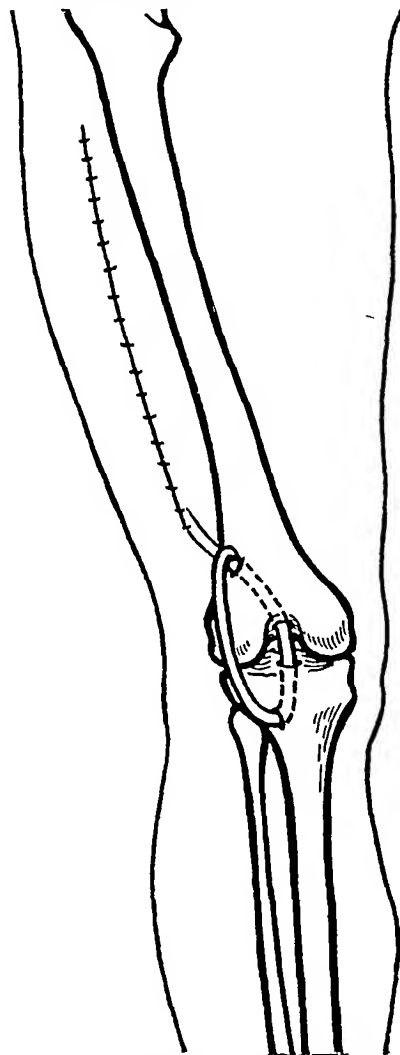
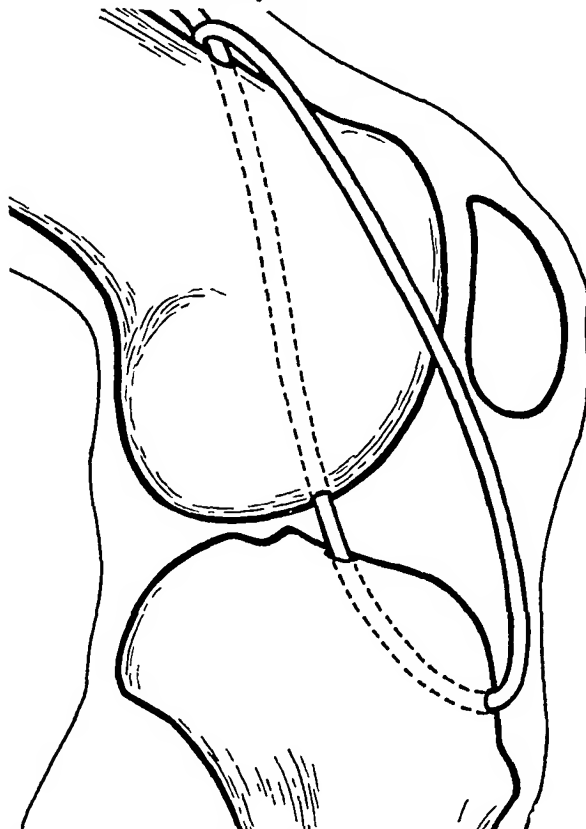
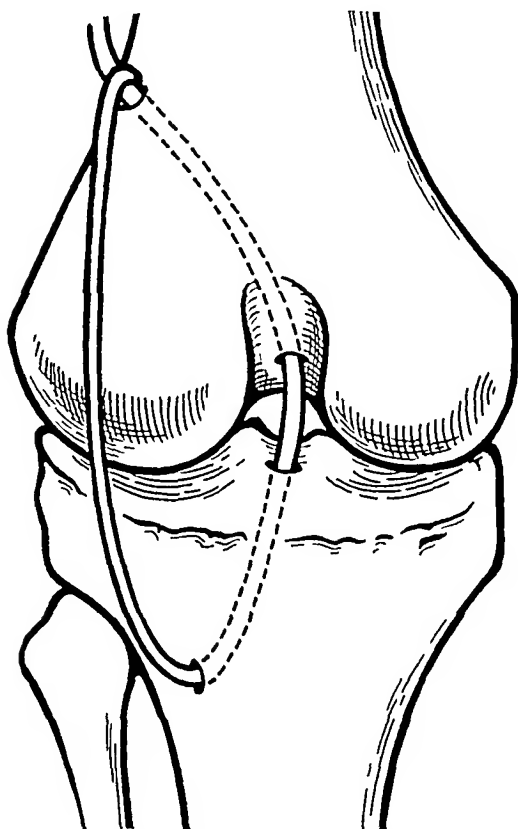


FIG 6—Indicates the bed from which the fasci lata strip is taken and the manner in which it is passed through the knee joint



Figs 7 and 8—Demonstrate the fasci lata passed through the knee joint in both the lateral and anteroposterior positions

of the knee joint and patella are sutured with interrupted chromic gut No 2, the knee joint being closed. The strip of fascia is now passed externally over the joint capsule, lateral to the patella, and fastened to itself at the point where the fascia entered the femur above the external condyle (Figs 7 and 8). The strip of fascia is also sutured to the capsule of the knee joint at intervals with interrupted sutures, all of this being done with the knee extended and the fascial strip pulled fairly taut. The skin wounds are now closed with fine chromic gut, and sterile dressings applied. To maintain extension of the knee joint, we use either a circular plaster of Paris splint from hip to toe, bivalved, or a posterior plaster shell. This splint is worn six weeks. After this time, the patient is fitted with a simple leg brace fastened into the shoe, with no motion at the ankle joint and a lock joint at the knee, and permitted to walk. After eight weeks, gradual motion is started in the knee joint with gentle massage. In about six months from the date of the operation, these patients have a good functioning, serviceable joint.

# THE EFFECTS ON BONE OF THE PRESENCE OF METALS, BASED UPON ELECTROLYSIS

AN EXPERIMENTAL STUDY

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THE reasons for undertaking these experiments on the reaction of bone to metals were, in the first place, the fact that extremely variable bone changes and clinical end-results have been observed when various metals recommended by research workers or by instrument houses have been used indiscriminately in the fixation of fractures. In the second place, we found much confusion in the reports of those who have performed exhaustive experiments to determine which metal or combination of metals was the most consistently tolerated by bone. Moreover, the directly contradictory opinions, and totally variable findings, of previous experiments gave us no clue as to the ideal metal or combination of metals for bone repair, upon which complete dependence could be placed.

Doisy,<sup>4</sup> in 1894, experimented with the then new metal, aluminum, and found that it produced irritation of the bone like any other foreign body. He concluded, however, that its salts were of weak toxicity and therefore that the metal was safe to use.

LeFort,<sup>13</sup> in 1918, observed that the body tissues reacted differently to bullets of different metals in spite of the absence of infection or other extraneous cases. He felt that the variations could possibly be explained by the action of the different metals used in alloys.

Algave<sup>1</sup> used silver wires in his experiments and stated that he was able to produce a chloride of silver which was harmful to the repair of bone.

Hey-Groves<sup>8</sup> claimed that nickel-plated steel did not produce any irritating effects on the tissues, and that magnesium produced destruction of bone if it was in contact with the cortex alone instead of in the medullary cavity. These experiments were quite rudimentary and were not checked by microscopic examination.

Rugh<sup>19</sup> experimented with 16 different types of metal, of which tiny pieces were placed in cultures of *Staphylococcus aureus* and *B. pyocyaneus*. He found that iron, steel, copper, zinc, and nickel, which are readily oxidized by body fluids, frequently cause aseptic suppuration. Silver, gold, and tin were unaffected by the body fluids.

Zierold<sup>21</sup> operated upon a number of dogs in which he drilled holes in numerous bones in various parts of the body and placed pieces of these metals in the holes. Gold, silver, aluminum, zinc, lead, copper, nickel, carbon, steel, stellite, etc. The tissues about the pieces of copper showed much dis-

coloration and marked overgrowth of the bone. About the gold, silver, and aluminum there was excessive subperiosteal growth of bone. Lead caused indifferent bone reaction. Nickel produced marked irritation and some stimulation of new bone. Iron and steel caused discoloration and soft tissue reaction. Gold, aluminum, and stellite were readily tolerated by bone and became encapsulated early. Silver and lead, which are easily corroded, caused more connective tissue reaction. Zinc was corroded readily and interfered markedly with bone regeneration. Zierold concluded that steel and iron definitely inhibit bone regeneration and that stellite causes the least reaction of all the metals used. (Stellite is an alloy containing 58 per cent cobalt, 35 per cent chromium, 4 per cent tungsten, plus small amounts of iron, carbon, etc.)

Trout<sup>20</sup> inserted steel screws in the bones of young rabbits and noted an arrest of growth of bone.

Leriche and Policard,<sup>16</sup> in their elaborate studies of the physiology of bone, found constant necrosis of bone under the metal plates which were used to immobilize fractures. After excluding injury, pressure, and infection as possible causes, they still found evidence of destruction which they assumed was due to the chemical nature of the fluids about the metals.

Jones and Lieberman,<sup>9</sup> in a recent thorough study, have shown that varying reactions of bone to metals result from the use of impure metals or from alloys of unknown composition. They experimented with small tacks of various types of rustless steels, which were placed in holes in the femurs of dogs. Five dogs were used. As the tacks were removed they were weighed to compare their weights before and after the experiments. Tacks of the same metals used in the dogs were soaked in Ringer's solution and kept at body temperature for 30 days to serve as controls. It was observed that there are many alloys in use which vary notably in chemical composition and that it is necessary to understand their composition to get the best clinical results. This is especially true of the new alloys known as rustless steel. It was suggested that no metal should be used in bone which is corroded rapidly by immersion in Ringer's solution. It was noted that there was much reaction in the soft tissues about all the screws which were used. Such soft tissue reaction seemed to be related in some way to metallic corrosion. The authors decided that chrome-nickel rustless steel was the best metal to use in bone, since corrosion of this metal was minimal. However, this alloy did irritate the bone somewhat.

Only an occasional observer has mentioned the possibility that electrolytic reactions between various metals used in bone repair surgery might be an explanation for the interference with bone growth which occurs in the presence of metallic fixation devices. A few French experimenters have proposed this idea, although they have failed to substantiate their inferences by careful chemical studies. Rolland,<sup>18</sup> for instance, experimented with silver, bronze, iron, and galvanized iron in bone and believed that the plates of metal were eroded by electrolytic action. However, he did not attempt to prove that this

explained the toxic effect of metals on the healing bone. Le Grand<sup>14</sup> repaired a fractured radius with a plate of steel and two circular wires. An excess of callus formed, and he wondered if the presence of these two metals bathed by the organic fluids of the body might not have formed a true electric couple which irritated the bone. He later performed several experiments in rabbits using copper, iron, and zinc, and even though there were few experiments, and these superficial, there was strong evidence that, with the two different metals in contact with bone, certain phenomena were produced which interfered with bone growth. Zierold,<sup>21</sup> whose work has been referred to before, suggested that the soft tissue reactions were mainly dependent upon the disintegration of the metals used. He did not, however, suspect electrolytic reaction. Galfre<sup>7</sup> assumed that electrolytic couples were to blame for all complications in the use of metal appliances in fracture work. He wondered if some of the unfavorable tissue destruction might not be due to the reaction of the metal and the calcium of the bone itself. He then erroneously concluded that the action of bone upon metal and the metal upon periosteum was the cause.

Cretin and Pouyanne<sup>2, 3</sup> attempted to explain the cause of variable reactions of metals on bone on a basis of cellular stimulation. They, therefore, were careful to experiment on normal bone with a minimum of trauma. They also studied all their specimens microscopically. Since the conclusions previously reported were so contradictory, they felt that much obscurity had been introduced into this problem. They operated upon guinea-pigs and placed metals such as aluminum, silver, copper, iron, magnesium, nickel, lead, and zinc in the bones. First they tried to see what action the metal would have if it were placed in the medullary cavity. Next they tried to see what action the metals would have if they were placed at the site of a fracture. They found that all the metals excited some degree of destruction which retarded growth of bone. This action also was essentially independent of location whether the metal was placed in the medullary cavity or directly on the bone surface. They tried to demonstrate that cellular reaction and calcification were inversely proportional to each other and that a metal which affected one did not affect the other.

In all these previous experiments, interpretations of results have depended upon macroscopic findings, tissue reactions, microscopic study which was but a magnification of the macroscopic detail, and some roentgenologic studies. Table I is arranged to show the wide variance of opinions resulting from these studies and the many inconsistencies thus far expressed as to the reactions of bone to metals.

Because of the wide difference of opinion resulting from former experiments and because of certain unpredictable clinical phenomena when metals are used in bone surgery, we assumed that there must be a variable factor yet undetermined. Our experiments therefore were undertaken to study the possibility that electrolysis might be the variable factor. In order to demonstrate this it was necessary first to study the reaction of normal bone to

TABLE I

CONTRADICTIONARY CONCLUSIONS OF VARIOUS AUTHORS ON THE EFFECTS OF METALS ON BONE

Metals Used	Metal Is Resorbed	Metal Is Not Resorbed	Indifferent Reaction	Partially Indifferent Reaction	Bone Growth Stimu- lated	Toxic Reaction on Bone	Bone Growth Inhibited	Bone Reaction Favorable
Alum- inum	Duval <sup>5</sup> Elsberg and Danborn <sup>6</sup>	Zierold <sup>1</sup> Cretin			Cretin <sup>2</sup>		Cretin <sup>2</sup>	
Silver		Metal oxidized	Lemerle <sup>15</sup>	Zierold <sup>21</sup> Cretin				
Copper		Rugh <sup>19</sup>	Cretin <sup>7</sup>		Cretin <sup>2</sup> Zierold <sup>1</sup> (distant)	Cretin <sup>2</sup> Zierold <sup>1</sup> (contact)		
Iron		Rugh <sup>19</sup>	Rolland <sup>18</sup> Trout <sup>20</sup>			Leriche and Polcard <sup>16</sup> Cretin <sup>7</sup>	Zierold <sup>1</sup>	Lange <sup>12</sup>
Mag- nesium	All ob servers				Lambotte <sup>10 11</sup> Cretin		Zierold <sup>21</sup> Cretin	
Nickel	Zierold <sup>1</sup>	Rugh <sup>19</sup>	Potarca <sup>17</sup> Cretin <sup>7</sup> Zierold <sup>1</sup> Cretin <sup>7</sup>			Zierold <sup>1</sup> Cretin Cretin	Zierold <sup>1</sup>	Hey- Groves <sup>8</sup>
Lead								
Zinc		Rugh <sup>19</sup>		Rolland <sup>18</sup>	LeGrande <sup>14</sup> Cretin <sup>7</sup>		Zierold <sup>1</sup> Cretin <sup>7</sup> Zierold <sup>1</sup>	
Steel	Zierold <sup>21</sup>							
Stellite			Zierold <sup>1</sup>					Zierold <sup>21</sup>
Chrome- nickel			Jones and Lieber- man <sup>9</sup>					Jones and Lieber- man <sup>9</sup>

various basic metals, plated metals, or combination of metals (alloys) in a control series of dogs. Two screws made of similar metal were placed in the bone where they would be bathed by the same electrolyte (body fluids) and where no electrolytic action would be expected.

In two subsequent series of dogs, screws of these same metals were placed in duo in the bones in different combinations to find whether or not there would be an electrolytic reaction between them. As the experiments proceeded, we performed biochemical examinations of the tissues and tissue fluids, screws, liver, and in some instances kidneys, of the dogs as they were sacrificed. This was done because we observed that simple macroscopic, microscopic and roentgenologic observations were too variable and inconclusive to be of value. It is obvious that the proof of electrolysis of tissue depends upon evidence of electrolytic action according to the laws of the electromotive force of metals either in the solution about the individual screws or upon the interchange of metal ions between the screws. A criterion for proof of electric activity was that, in the presence of different metals in duo in the same bone, if ions of one metal should be carried to the other, according to the laws of the order of electromotive force of metals, it would be due to electrolysis. The body fluids in these experiments acted as the electrolyte and biochemical analyses were performed to demonstrate the presence



or absence in the electrolyte of one or the other of the metals in solution adjacent to, or adherent to, the other metal, ad sensatum, in accord with this law

TABLE II  
THE ORDER OF THE ELECTROMOTIVE FORCE OF METALS

Metal	Electromotive Force (E M F )	Conductivity	Melting Point Degrees C
Aluminum	1 7000	324,000	659
Zinc	0 7618	186,000	419
Chromium	0 5570	83,200	1,615
Iron	0 4410	63,000	1,535
Cadmium	0 4010	95,000	321
Cobalt	0 2780	10,300	1,478
Nickel	0 2310	144,200	1,452
Tin	0 1360	76,600	232
Lead	0 1220	50,400	327 4
Antimony	0 1000	27,100	630
Copper	0 3440	591,000	1,083
Silver	0 7978	681,200	960 5
Platinum	0 8630	91,200	1,773 5
Gold	1 3600	468,200	1,062

In all of these experiments, of which upwards of 50 were made, each radius of each dog was used. In the right foreleg the radius was fractured obliquely with an osteotome (to produce a condition of traumatized bone), and the fracture fixed with the two screws. The left radius was not fractured and two screws were placed in the bone similarly to those in the fractured right radius. The wounds were closed, the legs were fixed in plaster encasements, and the dogs maintained under especially favorable conditions for periods of four, six, and eight weeks.

At the time the dogs were sacrificed the macroscopic changes in the tissues were noted and photographed in color. Roentgenologic examinations of the legs were made, also biochemical studies of tissues, of liquid exudates adjacent to the screw holes, and of the screws themselves. Chemical examinations of the livers and kidneys were also made in many of the experiments. Finally sections of bone, at the screw holes, were removed for microscopic study.

In several of the experiments we found evidence of a migration of ions of one metal to another, which in each case was in accordance with the sequence of the electromotive force of metals. We found in a few instances an actual deposit of particles of one metal upon another. In one animal the transference of ions had involved two separate processes: a deposit of the copper ions from a brass screw onto the chromium of the chromium-plated screw and a deposit of chromium ions from this latter screw onto the zinc

of the brass screw, all in accord with the order of electromotive force of metals. In several experiments, we found chromium in the livers and kidneys of dogs in which we had used the chromium-plated screws, and copper in large excess in the livers and kidneys in which brass or copper screws had been used. In dogs into which any form of steel had been inserted, whether plain or plated or in alloy, there was an excess of iron in the liver. Two of the dogs that died 15 to 20 days after operation had had chromium-plated steel screws used and a large amount of chromium was found in their livers. It is possible these deaths were due to chromium poisoning, since there was no other cause found at the autopsy, which included a careful analysis of the stomach contents.

In determining the electrochemical character of a given combination of metals, the volume of each piece of metal, the distance between them and the difference in potential of the electrolyte must be taken into detailed consideration. Thus the body fluids of each individual, though essentially the same qualitatively, differ quantitatively.

When pure metals are used alone in the body, there is some direct chemical action by the body fluids. In the instance that only one metal is used, any ensuing structural changes are due solely to chemical influence, because, of course, no electrolysis can occur in the presence of only one metal. But if impure metals are used in the body, singly or with other metals, there is a greater tissue reaction due to electrolysis between the various ions.

Thus our experiments with plated metals showed the greatest reaction of all because it was from plated metals that we were able to demonstrate the transference of metallic ions from one plated screw to the substance of another screw of different metal in compliance with the law of E M F. The reason is that when plating becomes eroded or chipped the body fluids can come in contact with the two metals side by side and a battery is at once established. This is forcibly illustrated in our experiments with chromium-plated steel screws.

Proof of electrolytic activity in the tissues is the fact that we have been able to recover chromium from the zinc of a brass screw, copper from the chromium of a chromium-plated steel screw, copper from a silver-plated steel screw and zinc from the substance about a galvanized iron screw, *etc.*, which is shown in the detailed description of the experiments. In such cases, the very great reaction of soft tissue and destruction of bone at the screw site we believe to be due to the electrolytic action engendered by two metals rather than to the intolerance of the tissue and bone to a single metal. For instance, a galvanized iron screw is a mixture of iron and zinc, about which there is invariably a marked reaction, whereas there is little change in the tissues about either iron or zinc alone. This fact has confused many other observers since they could not explain the great variance in the changes that were discovered.

In the use of alloys of "rustless steel" which are made of metals more resistant to body fluids it is impossible to prove electrolytic action by the

transfer of the integral metals of one onto the metals of the other. Such alloys are actually different metals. But in direct accord with the law of electromotive force of metals, if there is a marked disturbance about an alloy due to one element being put into solution in the given electrolyte, the action is undoubtedly due to electrolysis and the effect is due to hysteresis. (Hysteresis is a molecular disintegration of metals in an alloy due to variations of local electrical resistance.)

We have accepted the findings of Zierold<sup>21</sup> and of Jones and Lieberman<sup>9</sup> in their reports of their experiments with the rustless steels, and believe with them that these new metals, for such these alloys are, are more resistant to body fluids and so cause less reaction. But we differ with them in their resulting recommendations because of the presence in all rustless steels of such a high percentage of iron, which is so subject to the action of body fluids and which sets up hysteresis and local electrolytic changes in the alloys. Our experiments with an alloy called vitalium, which contains no iron, showed complete resistance to body fluids and no changes whatever in either the surrounding tissues or in the bone. This metal was used in many combinations

TABLE III

CHEMICAL COMPOSITION OF VARIOUS ALLOYS USED IN BONE WORK

STELLITE	"NICKEL FREE" RUSTLESS STEEL	"HIGH NICKEL" RUSTLESS STEEL	"LOW NICKEL" RUSTLESS STEEL	VITALIUM	PROPOSED POSSIBLE ALLOY
Cobalt 58%	Chromium 15%	Chromium 8%	Chromium 18%	Cobalt 65%	Cobalt 65%
Chromium 35%	Manganese 4%	Nickel 22%	Nickel 9%	Chromium 30%	Vanadium 30%
Tungsten 4%	Silicon 3%	Copper 1%	Manganese 4%	Molybdenum	Molybdenum
Iron 3%	Sulphur 5%	Silicon 1.5%	Iron 70%	5%	5%
Carbon	Molybdenum	Phosphorus	Carbon	Manganese	Manganese
	5%			Silicon	Silicon
	Carbon	Carbon			
	Phosphorus	Iron 65%			
	Iron 80%				
Contains iron, so increases electro-activity in alloy with added variance of E M F because iron more subjected to action of electrolytic organic acids	Chromium 15% 0 5570 E M F	Chromium 8% 0 5570 E M F	Chromium 18%	Chromium 0 5570 E M F	
	Iron 0 4410 E M F about 80%	Iron 65% 0 4410 E M F	Iron 70%	Cobalt 0 2780 E M F Molybdenum	
	Containing high per cent of iron	Nickel 22% 0 2310 E M F	Nickel 9%	Conductivity	
		Conductivity Chromium 83,200 Iron 63,000 Nickel 144,000	Lower per cent of chromium and nickel less E M F	Chromium 83,200	
		High electrolyte potential with variance conductivity	Smaller per cent of nickel less conductive potentiality	Cobalt 10,300 Melting Points Chromium 1615	
				Cobalt 1478	
				No iron	
				Least subject to action of electrolyte	

with other metals with uniform results as may be seen in the detailed report of our experiments

These experiments show that the various chemical, tissue, and bone reactions are changes due to electrolysis, when two metals are used in couples in the same bone, and explain why there has been so much tissue disturbance locally and such variable results clinically

In clinical orthopedic work electric couples are created by the use of plates, bands, wires, washers, lock nuts, *etc*, in conjunction with screws, nails, or other appliances so that two different pieces of metal are used in the same bone. Here Ohm's law becomes effective, *ie*, that an electric current is directly proportionate to electric conductivity and inversely proportionate to resistance. Conversely, metals that are more nearly of the same electric conductivity offer less resistance to a current between them

For example. The usual Lane plate furnished by instrument dealers is nickel-plated or chromium-plated steel, in which the iron is exposed at the holes into which screws of plain steel, chromium-plated steel, rustless steel, or galvanized iron are to be placed. What happens? Immediately an electrolytic action is started at the point of contact of each screw with the metal plate and the current is carried by the contacting plate to each other screw. There is then produced a progressive proliferative reaction in the tissues that is protective against the current. A necrosis and destruction of bone cells also takes place and an accumulation of discolored exudate, which contains elements of the metals in solution, forms about the metals and enters the circulation. In two weeks these screws, which were placed in the bone with forcible resistance, may be picked out with the fingers

As we have shown, we have recovered chromium from the livers of dogs that had only small chromium-plated steel screws in each radius. The suggestion implied by this finding, which was incidental, seems very important because of the extreme toxicity of chromium. Looking back on our clinical experience, we are sure we have seen patients, in whom devices plated with chromium had been introduced, become much more ill than seemed warranted by the operation itself, which makes one wonder if chromium poisoning may not have been responsible. We feel that further investigation of this factor is important because of the wide and indiscriminate use of chromium in plating or alloy in so many appliances used in osteosynthesis

Wire nails and galvanized nails are made of iron and zinc, and possibly some lead, copper nails and screws are usually copper with zinc or iron, steel screws commonly contain some zinc, while galvanized screws are usually made of iron plated with zinc. All of such metal devices as these have an electrolytic action whether used singly or in multiple, and if they are coupled together by like, or different material, the action is, in electrical terms, "stepped up"

Most of the nickel-plated and chromium-plated appliances sold today are not even electroplated, but instead are plated by chemical dipping. The outer coating of metal is easily chipped or rubbed off, or if the appliance is drilled

after plating, the two metals are exposed to direct contact at the screw holes with resulting electrolytic action. Such an assortment of materials courts the disaster we have so often seen clinically.

Electrolytic reaction to the different metals causes the collection of thin, brownish serous exudate about the site of the foreign metal *in vivo*, which, when chemically tested, contains the salts of the metals present in solution. The fluid collection is not due to infection, because this fluid, as well as the surrounding tissue, is microscopically bacteria free. As we have said, though, when metal ions from one screw are recoverable from another of different metal consistently with the law of E M F, it is due to electrolytic action and not solely to the chemical action of body fluids upon the metals themselves.

When screws have been placed too far apart in the bone to allow direct interchange of metal ions, there is a local electrolytic action in the screw itself between the metals of which it is made. This can be proved by a biochemical analysis of the tissues about the sites of these screws. To us this explains the interference with healing of fractures in which metal fixation of bone has led to necrosis and destruction of osseous tissue.

Finally, we believe that an alloy should be sought and developed that is entirely inert in the presence of, and unaffected by, biologic salts, to the extent that there will be no electrolytic action and that it shall have the strength to resist such stress or strain as it may have to bear.

#### EXPERIMENTAL PROCEDURES

In dogs anesthetized with intravenous nembutal, two screws, consisting of the various metals, alloys, and combinations as described, were placed in the bone about  $1\frac{1}{2}$  cm apart. The right radius was fractured in all the animals and the left radius was not, in order to check the reaction in each dog with and without trauma of the bone. Before the screws were placed, drill holes about two-thirds the size of the screw were made, in order to obviate the possibility of undue or variable pressure.

After the operations all wounds were closed with silk and the extremities fixed in a plaster encasement. The dogs were kept for observation in a well drained, shady corral, and fed separately with a selected, balanced diet.

#### EXPERIMENTAL RESULTS

##### CASE REPORTS

Dog 1—Operation May 29, 1936. Chromium plated screws used throughout. Died June 22, 1936. Autopsy showed no infection although there was extreme loss of weight. Stomach analysis was negative except for chromate test which showed suggestion of chromium poisoning—more suspicious in subsequent experiments.

Röntgenologic Examination—Necrosis of bone around all the screw holes. There was considerable tissue reaction about both operative sites. The fracture of the right radius was united. All the screws were loose one plus.

Dog 2—Operation May 30, 1936. Plain Steel screws used throughout. Sacrificed July 20, 1936.

Röntgenologic Examination—Right. There was nonunion of the fracture with destruction of bone and proliferation of callus.

Left. Destruction of bone about the screws with proliferation of new bone over screw heads. All screws were loose four plus.

Autopsy—Macroscopic. Right. Nonunion of fracture with inflammatory soft red tissue over screw head and about the fracture site for 2 or 3 cms.

Left. There was much bone destruction with soft tissue necrosis for  $\frac{1}{2}$  to 1 cm beyond screw heads. Other bone normal. Much excess bone for about  $\frac{1}{2}$  cm around the screw.

Dog 3—Operation May 29, 1936 *Vanadium Steel* screws used throughout Sacrificed July 29, 1936

Roentgenologic Examination—Fracture united Slight reaction in the shaft with destruction of bone at the screw heads and proliferation of new bone

Autopsy—*Macroscopic Left* The screws were tight in their sockets and both were covered with much fibrous tissue Rim of bone was beginning to cover heads of screws No discoloration of soft tissue near proximal screw Excessive scar tissue near distal screw head

*Right* The screw head was completely covered by loose, adherent transparent fibrous tissue with faint brownish discoloration Screw was loose Fracture was united without excess callus Slight necrosis over the head of screw

Dog 4—Operation June 3, 1936 *Silver Wire* used throughout Sacrificed August 7, 1936

Roentgenologic Examination—*Right* Fracture was united Excessive proliferation of new soft bone

*Left* Silver pegs had worked out of place Destruction of bone at the sites of both pegs

Autopsy—*Macroscopic Right* There was firm bony union of the fracture with an excess of firm callus There was a slight accumulation of tan colored fluid in a bursal sac immediately over the wire head Excessive fibrous tissue was present for about 1 Mm about the wire

*Left* Both wires had apparently worked out of the bone and become encysted No necrosis at the holes Holes were nearly filled with proliferation of new bone Light brown discolored fluid about the wires No infection

Dog 5—Operation June 3, 1936 *Silver Plated Steel* screws used throughout Sacrificed August 7, 1936

Roentgenologic Examination—Showed necrosis of bone at all screw sites with a marked proliferation of soft callus



FIG 1—Dog 5 Silver plated steel throughout Roentgenogram showing marked necrosis of bone at all screw sites note destruction about single screw



FIG 2—Dog 5 Silver plated steel throughout Showing tissue reaction Fracture ununited Soft encapsulated seminecrotic tissue tannish discolorations around heads of screws all of which were very loose

Autopsy—*Macroscopic Right* Fracture was ununited Screw was loose The hole was covered with an excess of fibrous tissue for  $2\frac{1}{2}$  Mm There was soft seminecrotic tissue lining an encapsulated area over the head of the screw There was a moderate increase of soft callus

*Left* There was an excess of soft callus about the screws Proximal screw was very loose Distal screw was engaged Bluish tan discoloration over heads of screws which were encapsulated by fibrous tissue 2 Mm thick

Dog 6—Operation June 3 1936 *Copper Nails* used throughout Sacrificed August 5, 1936

Roentgenologic Examination—*Right* Union of fracture Peg had worked out of bone Necrosis with excessive proliferation

*Left* Necrosis with excessive proliferation All pegs were loose four plus

Autopsy—*Macroscopic Right* There was fibrous union of the fracture with excessive fibrous tissue about the fragments The copper nails had been displaced and were resting parallel to the bone There was an excessive amount of fibrous tissue about the operative wound About one nail there was a good deal of tissue necrosis with brownish fluid and tan discoloration No pus

*Left* There was destructive necrosis near the holes where the copper nails were placed There was marked necrosis also about the heads of the nails for  $1\frac{1}{2}$  cm Beyond this was an area of marked proliferation of new bone There was an excess of fibrous tissue almost completely covering the heads of the nails This extended to 1 Mm beyond the head of the proximal copper nail The same was true of the distal nail although the hole was about twice the size of the nail There was a slight soft tissue necrosis about the heads of both nails

Dog 7—Operation June 10, 1936 *Copper* nail distal and *Steel* screw proximal on the left side Reversed in the fractured right radius Died July 16 1936

# ELECTROLYSIS IN METAL BONE PEGS

**NOTE** In all the subsequent experiments with different combinations of metals in the same bone the arrangement of proximal and distal screws was reversed in the two legs to avoid any possible effect of gravity, or of contact of the solution of metals.

**Roentgenologic Examination—Right** Union of fracture. Necrosis of screw site and screw loose three plus.

**Left** Slight change. Screws loose one plus. There was a sinus in the operative wound with evidence of a small abscess at the operative site and nails had worked out of the bone. Fracture was solidly healed in spite of infection. Tissue was necrotic around the wound.

**Left** The copper nail was tight in the bone. Its surface was shiny. There was no apparent tissue necrosis in the region. The steel nail was not tight in the bone and it appeared firm. The soft tissue about the steel nail was discolored a dirty gray. Also this tissue showed evidence of liquid necrosis.

**Dog 8—Operation June 10, 1936** Copper nail proximal and galvanized iron screw distal on left. Reversed on the right. Died June 22, 1936. No autopsy. Cause of death unknown.

**Roentgenologic Examination—Much** destruction of bone.

**Autopsy—Macroscopic** In both legs there was much tissue proliferation with excess of tan colored fluid. No infection.

**Dog 9—Operation June 10, 1936** Chromium plated screw proximal and copper nail distal on left. Reversed on the right.

**Roentgenologic Examination—Showed** marked bony necrosis at all screw sites, more marked with much more destruction at site of copper nails.



**Fig 3--Dog 11** Silver and chromium plated steel. Roentgenogram showing bone necrosis around the chromium but none is present adjacent to the silver.

**Fig 4--Dog 11** Silver and chromium plated steel. Showing tissue reaction. Marked reaction evident around the chromium plated steel screw which was loose. Very slight if any reaction present around the silver.

**Autopsy—Macroscopic Right** Bony union of the fracture in good position. There was some destructive necrosis about the chromium plated screw throughout its entire length. There was more destruction about the copper nail. The screw which was loose. Very slight if any reaction present around the silver.

**Left** Decidedly more absorption of bone about the copper nail. Apparently no destruction about the chromium plated screw. There was an excess of callus and fibrin about the copper nail. The screw was moderately loose and free in the hole. Slight amount of necrosis.

**Dog 10—Operation June 13, 1936** Plain steel screw proximal, and chromium plated screw distal on the right. Reversed on the left. Sacrificed June 21, 1936, because of compound fracture and gross infection. Not suitable for chemical study.

**NOTE** At this stage of the experiments biochemical studies were begun of the tissues of the legs adjacent to the different screws, of the screws themselves, and of the livers and kidneys of the dogs as they were sacrificed.

**Dog 11—Operation June 13, 1936** Chromium plated screw proximal, and silver peg distal on the left. Reversed on the right. Sacrificed September 1, 1936.

**Roentgenologic Examination—Showed** marked necrosis about chromium plated steel screws. None about the silver pegs.

**Autopsy—Macroscopic Right** Around the distal chromium plated screw there was soft reddish tan fibrous tissue. Screw was loose two plus. Brown discoloration around the margin of the hole with

excess callus About the proximal silver peg there was no discoloration, no necrosis, no looseness, no callus

*Left* The head of the proximal chromium plated screw was completely covered flush with callus There was very dark brown necrotic material over the screw head Soft tissue around the bone was dark brown and necrotic Screw was loose three plus The distal silver peg was out of the hole in the bone and was encapsulated in soft fibrous tissue

*Biochemical Analysis* The soft tissues of the leg were positive for chromium about the chromium plated screw on the left The liver and both kidneys showed positive chromium tests

*NOTE* The discovery of chromium in the liver in this dog suggested the possibility that Dog 1 may also have died of chromium poisoning, particularly since the stomach contents showed a positive chromate test although strychnine was not present

*Histologic Examination*—Right proximal screw, silver Moderate periosteal reaction with formation of moderate amount of chronic granulation tissue No suppuration present No evidence of bone regeneration about edges of screw hole Moderate amount of bone degeneration present, however

Right distal screw, chromium steel No periosteal reaction noted No granulation tissue formation present Bone undergoing marked degenerative changes

Left proximal screw, chromium steel Marked periosteal reaction around edges of screw hole with thickening and increased vascularity Large collections of plasma cells, lymphocytes and multinucleated cells Marked production of granulation tissue Some bone degeneration No osteoplastic activity noted

Left distal screw, silver Marked granulation tissue formation with thickening and increased vascularity of periosteum Some callus formation with moderate osteoplastic activity and with numerous

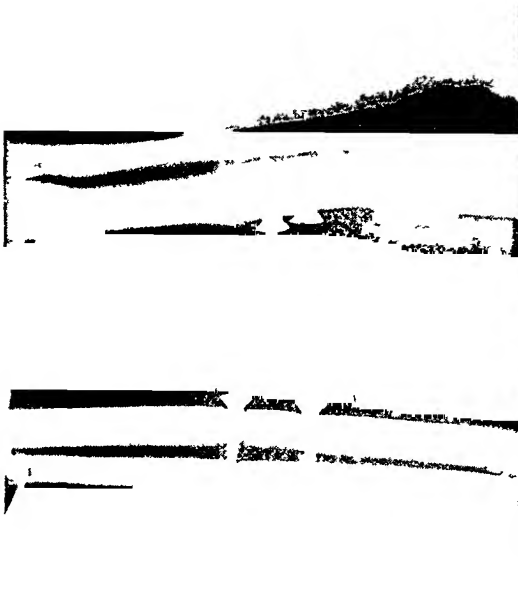


FIG 5—Dog 12 Silver plated copper and steel Roentgenogram showing moderate bone necrosis evident around all the screws



FIG 6—Dog 12 Silver plated copper and steel Showing tissue reaction There is tan to black discoloration about the silver plated copper screws All screws are loose except the steel one in fractured radius

osteoblasts scattered throughout granulation tissue In one area there appears to be a chronic suppurative process

Dog 12—Operation June 13, 1936 Plain Steel screw proximal, and silver plated copper screw distal on the left Reversed on the right Sacrificed September 1, 1936

Roentgenologic Examination—There was union of the fracture with moderate necrosis about all screws

*Autopsy—Macroscopic Right* In the bone about the proximal silver plated copper screw there was brownish black discoloration and semifluid degeneration Screw was loose one plus Around the distal steel screw there was black discoloration The screw was tight and there was no fluid

*Left* About the distal silver plated copper screw there was much thin, pale tan fluid with similar tan discoloration of the tissue Screw was very loose three plus There was liquefying necrosis About the proximal steel screw there was black discoloration but no fluid Screw was loose two plus

*Biochemical Analysis* There was an excess of copper in the liver and kidneys There was erosion of the silver plated copper screw in several places with traces of copper in solution in the adjacent tissues

*Histologic Examination*—Right proximal screw, Steel Mild general reaction with small amount of granulation tissue formation Mild bone necrosis Regenerative changes slight

Right distal screw, Silver plated copper Mild degree of granulation tissue formation Mild degree bony degeneration General reaction very slight

Left proximal screw, Silver plated copper Moderate degree of bone necrosis No evidence of granulation tissue formation or callus formation



Left distal screw, steel Marked granulation tissue formation Callus formation with some bony regeneration present

Dog 13—Operation July 28, 1936 *Vitalium screw* proximal and *Vanadium Steel screw* distal on the right Reversed on the left Sacrificed August 7, 1936, because of severe screw worm infection of mouth

Roentgenologic Examination—Fracture united with solid bony union Vanadium steel screws loose Vitalium screws firmly in place In the left leg there was no bony necrosis about the vitalium screw About steel screws much bone necrosis and tissue reaction

Autopsy—*Macroscopic Right* Fractured ulna found to be solidly healed Both vanadium steel screws were in place snugly Vitalium screws were very tight and considerable force was required to remove them There was very slight soft tissue reaction about the vanadium steel and none about the vitalium

Left Essentially the same findings as on the right

Biochemical Examination negative

Histologic Examination—Right proximal screw, Vitalium Periosteum moderately thickened, but no granulations noted Periosteum dense, relatively acellular with few blood vessels present No bone necrosis noted, but there is a large wedge of what appears to be new bone present General tissue reaction is of slight intensity

Right distal screw, vanadium steel Moderate degree of periosteal thickening with a moderate granulation tissue formation about edges of screw hole This tissue is undergoing extensive liquefaction necrosis A few small foreign body giant cells are noted along junction of periosteum and granulation tissue No bone necrosis is noted General tissue reaction is one of moderate degree

Left proximal screw, vanadium steel Mild periosteal reaction with a very small amount of granulation tissue present Tissue reaction slight although there appears to be a slight amount of bone necrosis

Left distal screw, vitalium There appears to be little tissue reaction of any character, although a small amount of granulation tissue is observed No bone necrosis

Dog 14—Operation August 21, 1936 *Galvanized iron screws* used throughout Sacrificed November 2, 1936

Roentgenologic Examination—*Right* Fracture ununited and angulated Much necrosis and bony atrophy All screws loose four plus

Left Necrosis at the screw sites Screws loose four plus No new bone growth

Autopsy—*Macroscopic Right* There was nonunion of the fracture in poor position There was much fibrous tissue over the ends of the bone About the proximal screw there was much destruction of bone The distal screw was out of the bone in a cavity surrounded by amber fluid

Left There was very little proliferation of soft fibrous tissue with some pale tan discoloration Both screws were loose four plus, with destruction of bone about the tips of the screws Periosteum about the margin of the screw heads and between the screws was completely destroyed

Biochemical Analysis Zinc present in adjacent fluids Liver was not tested for zinc

Dog 15—Operation August 21, 1936 *Vitalium screw* was placed proximally, and *galvanized iron* distally on left Reversed in right leg Died September 17, 1936 Cause of death unknown

Roentgenologic Examination—*Right* Union of fracture Destruction about proximal screw No change about distal vitalium screw

Left No destruction near proximal screw Destruction about galvanized screw

Autopsy—*Macroscopic Right* There was an hematoma in the leg about the proximal galvanized iron screw and the screw was loose two plus The distal vitalium screw was tight

Left There was a small abscess over both screws in the field of the operation The vitalium screw was covered with a transparent membrane and both screws were tight

Biochemical Analysis Negative

Dog 16—Operation July 18, 1936 *Chromium plated steel screws* used throughout Sacrificed September 8, 1936

Roentgenologic Examination—Showed moderate destruction of bone about heads of all screws Bony union of fracture

Autopsy—*Macroscopic Right* The fracture was solidly healed and there was deep brown discoloration about both screws The proximal screw was tight The distal screw was covered with brown transparent areolar tissue

Left The distal screw had marked black discoloration of the tissue for a wide area The screw was tight, although there was destruction of bone about the head of the screw from 3 or 4 Mm The proximal screw was tight with destruction of bone for 1 Mm about the head

Biochemical Analysis Much chromium in soft tissues adjacent to screw Trace of chromium in the liver

Histologic Examination—Chromium plated steel screws throughout

Right proximal Moderate degree of periosteal thickening which has a shredded appearance Small amount of granulation tissue present Mild degree of bone necrosis

Right distal Mild degree periosteal thickening No granulation tissue formation present No bone necrosis—irritative changes slight in degree

Left proximal Periosteum mildly thickened with a moderate degree of granulation tissue formation which is undergoing organization A few foreign body giant cells are scattered through the granulation tissue General irritative changes are of moderate degree

Left distal Moderate degree of periosteal thickening with a moderate degree of granulation tissue formation No bone necrosis noted General tissue reaction is slight to moderate

Dog 17—Operation July 18, 1936 *Plain Steel screw* proximal and *brass screw* distal on the left Reversed on right Sacrificed September 9, 1936

Roentgenologic Examination—Union of fracture Destruction of bone about all screws, more marked about the brass

Autopsy—*Macroscopic Right* The distal steel screw was tight with some fibrous tissue over the

head The proximal brass screw was loose two plus with a slight amount of boggy tissue over the screw head

*Left* Both screws were very loose four plus There was much new bone about both screws with erosion about the heads and much brownish discoloration over the proximal steel screw

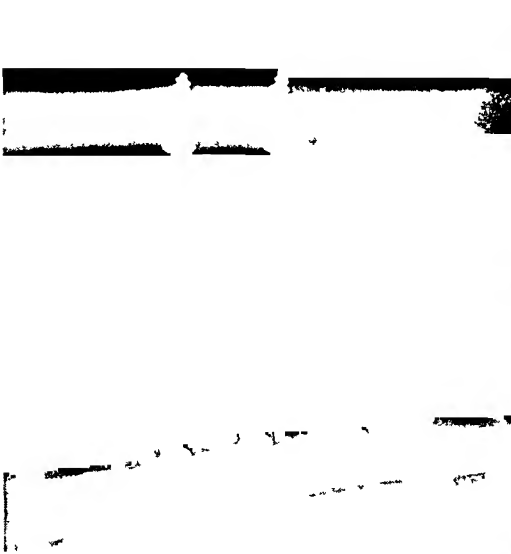


FIG 7—Dog 16 Chromium plated steel Roentgenogram showing moderate necrosis of bone about all the screws



FIG 8—Dog 16 Chromium plated steel Showing tissue reaction There is marked local reaction around all screws with excess proliferation and dark discoloration The screws are tight

*Biochemical Analysis* Iron and copper present in the soft tissues adjacent to the screws Greater quantity present on the left side because the screws were closer together Much iron found in the liver

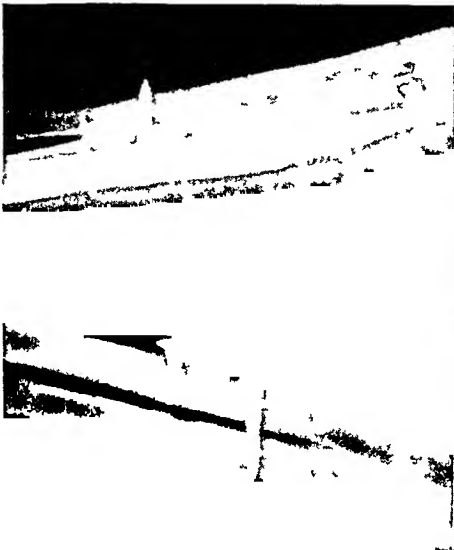


FIG 9—Dog 17 Steel and brass Roentgenogram showing destruction of bone about all the screws with marked necrosis around the brass



FIG 10—Dog 17 Steel and brass Showing tissue reaction There is much new soft bone with marked fibrous proliferation All the screws are very loose except the steel one in the fractured radius

*Histologic Examination*—Right proximal screw brass Moderate amount granulation tissue formation with marked periosteal thickening No bone necrosis Some new cartilage present  
Right distal screw, Steel Marked thickening and fibrosis of periosteum with moderate osteoblastic

# ELECTROLYSIS IN METAL BONE PEGS

activity marked Moderate degree of granulation tissue formation No bone necrosis Irritative changes not marked

Left proximal screw, steel Marked periosteal thickening and fibrosis with a very slight amount of granulation tissue formation present No bone necrosis Numerous osteoblasts present

Left distal screw, brass Marked callus formation with thickening of periosteum No granulation tissue formation noted or has become organized into callus New cartilage formation noted Few irritative changes present

Dog 18—Operation July 18, 1936 Brass screw proximal and galvanized iron screw distal on the left Reversed on the right Sacrificed September 9, 1936

Röntgenologic Examination—Union of fracture All screws loose except proximal brass in left Much destructive necrosis of bone at all screw sites

Autopsy—Macroscopic Right The distal brass screw was loose two plus There was no necrotic material No fluid and moderate proliferation of new bone The proximal galvanized iron screw was loose four plus There was much new bone about the margin of the screw head

Left The proximal brass screw was firmly fixed in the bone The distal galvanized iron screw was loose four plus There was much new bone about both screws with more about the proximal There was brownish discoloration of the seminecrotic material around the distal screw

Biochemical Analysis Liver showed heavy trace of copper Trace of copper and zinc in tissue adjacent to the screws

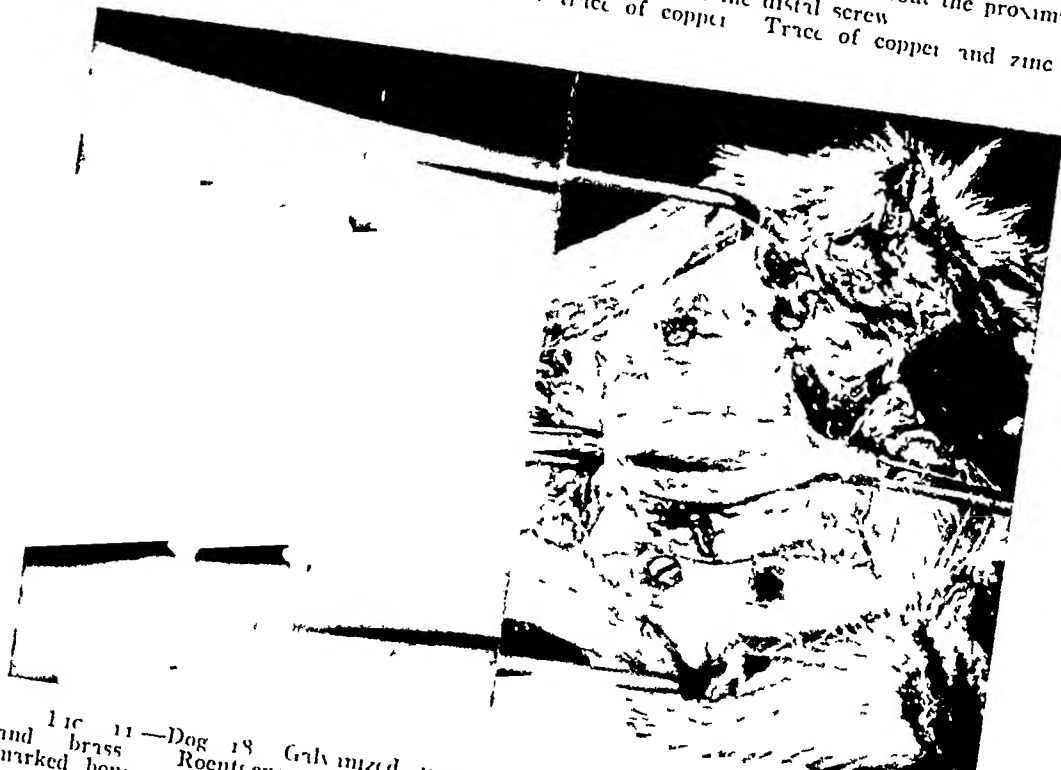


FIG. 11—Dog 18 Galvanized iron and brass Roentgenogram showing marked bone necrosis around all screws

FIG. 12—Dog 18 Galvanized iron and brass Showing tissue reaction There is present brown discoloration with proliferation of soft, fibrous tissue. All screws loose

Histologic Examination—Right distal screw, brass Moderate degree of periosteal thickening around screw hole No granulations present No irritative reaction No callus or bony regeneration Process appears generally indolent with some necrosis in tissue lining the screw hole

Left distal screw, galvanized iron Mild degree of periosteal thickening around edges of screw hole with a marked degree of granulation tissue formation Numerous large cells (osteoblasts?) scattered through granulation tissue which contains numerous inflammatory cells Appearance is that of a marked tissue reaction of irritative character

Dog 19—Operation July 21, 1936 Plain Steel screw proximal and vitallium screw distal on the left Reversed on the right Sacrificed September 9, 1936

Röntgenologic Examination—Union of fracture Distal steel screw on the right loose four plus with erosion about the head Vitallium caused no reaction On the left the vitallium screw was slightly loose, and the steel screw was loose three plus There was a ridge of new bone 2 Mm high on the medial side of the steel screw

Autopsy—Macroscopic Right The proximal vitallium screw was about 50 per cent covered with normal new bone The screw threads were intact and the screw could be unscrewed easily There was no discoloration and no abnormal bone The distal steel screw was loose three plus There was much excessive new bone around the margin of the head with a mass of encapsulated brownish soft tissue over the head

Left The proximal steel screw was loose three plus with a small amount of soft brown discoloration of the adjacent tissue The distal vitallium screw had worked loose On the medial side of the hole was a ridge of new bone about 2 Mm high (? torn periosteum) There was no discoloration

Biochemical Analysis Vitallium screws showed no trace of iron about them About steel screw was

proliferation of iron into soft tissue Excessive amount of iron in the liver No trace of chromium or cobalt in the liver

*Histologic Examination*—Right proximal screw, steel Little tissue reaction present Periosteum



FIG 13—Dog 19 Vitalium and steel Roentgenogram showing no bone changes about vitalium and erosion of bone around the steel screws

FIG 14—Dog 19 Vitalium and steel Showing tissue reaction No changes about vitalium one vitalium screw is one plus loose, marked reaction about all steel screws which are very loose

not thickened, dense and relatively acellular Small amount of granulations present which appear partially necrotic

Right distal screw, vitalium Mild periosteal thickening small amount of granulation tissue present Marked regeneration of bone probably along fracture site

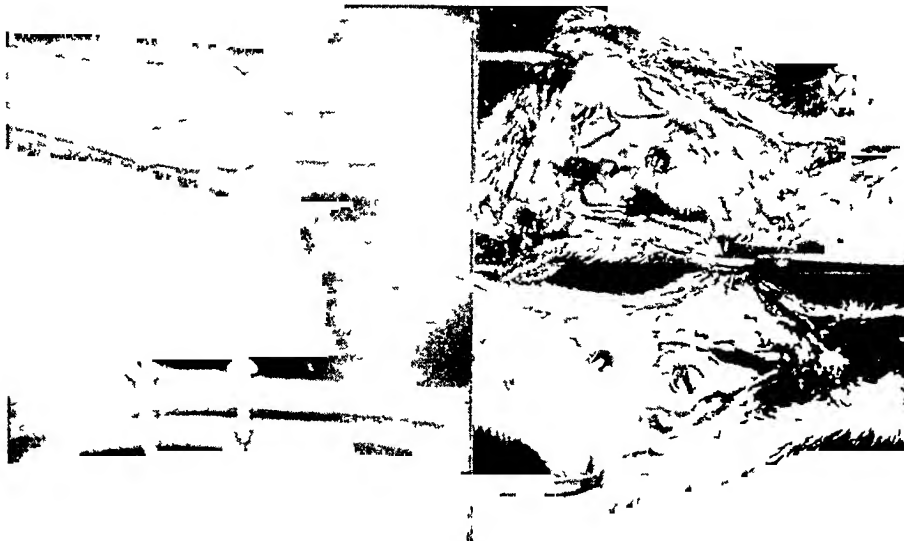


FIG 15—Dog 20 Vitalium and brass Roentgenogram showing no change around vitalium screws marked bone destruction about brass screws

FIG 16—Dog 20 Vitalium and brass Showing tissue reaction No reaction adjacent to vitalium, tissue destruction with proliferation about both brass screws, which are four plus loose

Left proximal screw vitalium No periosteal thickening noted Periosteum covered with a moderately thick layer of granulation tissue which is undergoing early organization No foreign body giant cells noted General tissue reaction is not marked

Left distal screw, steel Moderate periosteal thickening with fibrocystic proliferation and formation

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of a few foreign body giant cells near periosteal attachment to bone. Lining the screw hole is a thick layer of granulation tissue undergoing organization. General tissue reaction is marked.

Dog 20—Operation July 21, 1936. *Brass screw* proximal and *vitallium screw* distal on the left. Reversed on the right. Sacrificed September 9, 1936.

Roentgenologic Examination—Fracture solidly united. No bony changes about either vitallium screws and they were tightly in place. There was necrosis of bone about both brass screws which were loose.

Autopsy—*Macroscopic*. *Right*: Over the distal brass screw there was a large mass of reddish brown encapsulated tissue. All the neighboring soft tissue was boggy. The proximal vitallium screw was loose four plus. There were no threads in the hole and the screw had apparently been placed between the fragments of the fracture. There was no bony proliferation about the head.

*Left*: The distal vitallium screw was very tight. There was no discoloration and no destruction of the bone. The proximal brass screw was loose four plus with much necrotic material around the screw. There was little proliferation of new bone.

Biochemical Analysis: Copper in tissue adjacent to screws in right foreleg. Trace of copper in the liver.

Histologic Examination—Right proximal screw, vitallium. Mild periosteal thickening about edges of screw hole, but no granulations noted. Process here appears relatively indolent with what appears



FIG 17—Dog 21. Galvanized iron and brass. Roentgenogram showing much destruction of bone about all screws.

FIG 18—Dog 21. Galvanized iron and brass. Showing tissue reaction. Soft brown granular tissue about galvanized iron screw and soft fibrous tissue brass screws, all screws are loose except one of the brass ones.

to be a mild degree of necrosis taking place. The bony elements show no necrosis and deeper there is a wide, dense callus in process of formation.

Right distal screw, brass. Periosteum somewhat thickened but is split up and shredded in appearance from exudative material. There appears to have been a marked granulation tissue formation but this is undergoing advanced liquefaction necrosis, and is not definitely recognizable as granulation tissue. There is a slight degree of bone degeneration just beneath periosteum. No new bone formation noted.

Left proximal screw, brass. Marked thickening and fibrosis of periosteum about edges of screw hole but only a very slight granulation tissue formation. No bone necrosis noted. No bone regeneration.

Left distal screw, vitallium. General tissue reaction very slight. Periosteum not thickened, but heavily infiltrated with cells similar to plasma cells and lymphocytes. A very slight granulation tissue formation is present. In one area at edges of screw hole there is a small area of bony necrosis while in another area there is a definite but slight degree of new bone formation.

Dog 21—Operation July 21, 1936. *Brass screw* proximal and *galvanized iron screw* distal on left. Reversed on right. Sacrificed September 8, 1936.

Roentgenologic Examination—Union at fracture site. All screws loose with much destruction of bone.

Autopsy—*Macroscopic*. *Right*: Fracture solidly united. The proximal galvanized iron screw was surrounded by boggy tan granulation tissue on the proximal side. The screw was only slightly loose. The distal brass screw was tightly engaged with much slightly discolored new bone growth and dense fibrous tissue covering the screw.

*Left*: The proximal brass screw was loose two plus. There was some discoloration and erosion of the soft tissue about the screw but no fluid. The distal galvanized iron screw was loose three plus with

a small amount of free fluid about it. There was destruction of the bone without metallic discoloration and considerable boggy fibrous tissue about the screw head.

**Biochemical Analysis** Much iron in soft tissue adjacent to screws. Trace of copper deposited on galvanized iron screw.

**Histologic Examination**—Right distal screw, brass. Marked periosteal reaction with moderate thickening. Moderate degree of granulation tissue formation with almost complete organization. Moderately advanced callus formation deep in bone along probable fracture line with new bone formation taking place. General tissue reaction of moderate degree of intensity.

Right proximal screw, galvanized iron. Mild periosteal reaction with mild degree of thickening. Moderate degree of granulation tissue formation with a slight organization beginning to take place. Numerous degenerating bony fragments scattered through granulation tissue. Some evidence of bone regeneration present but this is not marked. General tissue reaction is of moderate degree.

**NOTE** In Dogs 21 and 22, screws happened to be placed in closer approximation than in the other experiments.

**Dog 22**—Operation July 28, 1936. Brass screw proximal and chromium plated screw distal in left. Reversed on right side. Sacrificed August 17, 1936.

**Roentgenologic Examination**—Union of fracture. All screws were loose and showed necrosis with excessive proliferation of new bone at all screw sites.



FIG 19—Dog 22 Chromium plated steel and brass. Roentgenogram showing proliferation of new soft bone with necrosis at all screw sites.

FIG 20—Dog 22 Chromium plated steel and brass. Showing tissue reaction. Black stain about the chromium plated screws. Slight reaction about all screws which are very loose.

**Autopsy—Macroscopic** Right. The periosteum near the fracture was bulging with an accumulation of brownish serous exudate. The fracture was united with excessive proliferation of new bone. The brass screw was loose and free to rotate. The chromium plated screw had new bone about it but no destruction of periosteum. The screw was loose and there was a small area of erosion at the margin where it touched the bone. The edges of the hole were black.

Left. The brass screw was tightly engaged. The tissues seemed healthy except for an area about 1/2 cm. around the chromium plated screw where there was a low grade tissue necrosis with pinkish gray secretion. There was a proliferation of fibrous tissue about the brass screw which seemed normal. About the chromium plated screw there was no new bone growth and there was degenerative necrosis in the screw hole.

**Biochemical Analysis** Copper was deposited on chromium plated screws and chromium on the zinc of the brass screws in both legs. (NOTE: According to the Table of E.M.F. copper should be deposited on to chromium, chromium on to zinc.) Trace of chromium in the liver.

**Histologic Examination**—Right proximal screw, chromium plated steel. Moderate periosteal thickening with moderate degree of granulation tissue formation. Moderate number foreign body giant cells scattered through periosteum and granulation tissue. Marked bone regenerative changes present. General tissue reaction changes are marked.

Right distal screw, brass. Moderate periosteal thickening with moderate degree of granulation tissue formation. Moderate number foreign body giant cells scattered through periosteum and granulation tissue. Marked bone regenerative changes present. General tissue reaction changes are marked.

Left proximal screw, brass. Marked periosteal thickening with small amount of granulation tissue formation. Numerous foreign body giant cells in periosteum. Mild degree of bone degeneration present near margin of screw hole. Irritative tissue reaction moderate.

Left distal screw, chromium plated steel. Marked degree of periosteal thickening with moderate

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degree of granulation tissue formation Moderate degree of new bone formation along line of fracture with marked callus formation General tissue reaction moderate to marked

Dog 23 —Operation July 23 1936 Steel screw proximal and silver plated copper screw distal on left Reversed on right Sacrificed September 3 1936

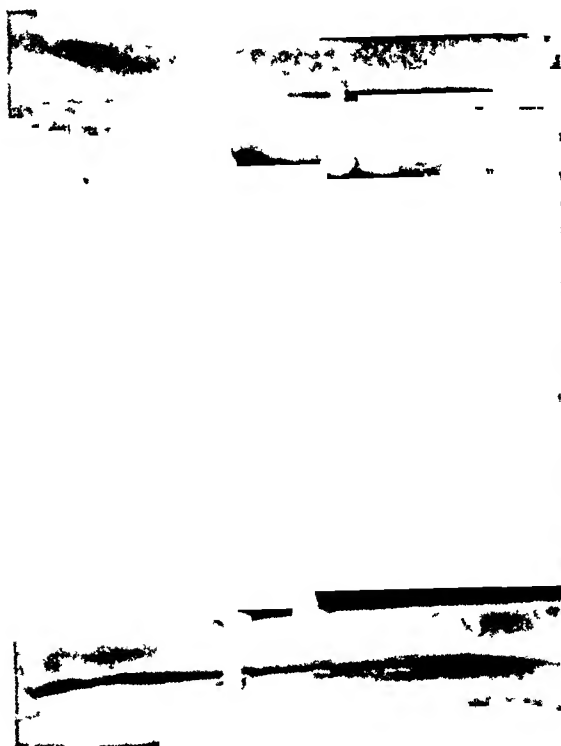


FIG. 21—Dog 23 Silver plated copper and steel Roentgenogram showing proliferation of new bone at fracture site Necrosis at all screw sites



FIG. 22—Dog 23 Silver plated copper and brass Showing tissue reaction Gray exudation about the copper screws with brown discoloration about the brass screws All screws loose



FIG. 23—Dog 24 Vitallium throughout Roentgenogram showing no change around screws except one in fracture site, about which there is new bone growth



FIG. 24—Dog 24 Vitallium throughout Showing tissue reaction Granulation around the one screw in fracture site none about the remaining screws, all of which were very tight

Roentgenologic Examination—Union of fracture All screws loose with slight necrosis and much new bone

Autopsy—*Macroscopic Right* There was a small amount of grayish secretion on the proximal

side of the distal steel screw. The head of the screw was completely covered with new bone. The silver plated copper screw was loose two plus. There was a small amount of callus and some brownish fluid about the edges of the screw.

*Left* There was an excess of brown tissue about the steel screw and the screw was loose two plus. The silver plated copper screw was tightly engaged. Both screw heads were encapsulated and there was a small amount of tannish tissue about the head of each. There was some formation of new bone about the steel screw but the screw itself was loose in the hole.

*Biochemical Analysis* Trace of copper about the steel on the left. Trace of copper in the liver.

*Histologic Examination*—Right proximal screw, silver plated copper. Slight to moderate degree of periosteal thickening. Granulation tissue formation slight to moderate with low grade inflammatory reaction. Numerous eosinophiles scattered throughout granulation tissue. General tissue reaction appears to be of moderate degree.

Right distal screw, steel. Marked thickening of periosteum which appears dense and fibrous. Moderate granulation tissue formation with a low grade chronic inflammatory process. Some hemorrhage and fibrinous exudation in deeper tissues. General irritative tissue reaction may be classed as moderate.

Left proximal screw, steel. Periosteum shows a slight to moderate degree of thickening with only a small amount of granulation present. No giant cells observed. General tissue reaction appears to be slight.

Dog 24—Operation July 23, 1936. *Vitalium screws* used throughout. Sacrificed September 8, 1936.

*Roentgenologic Examination*—There was union at fracture site. No reaction about screws except one in the fracture site, which showed proliferation of new bone. No inhibition of bone growth in fracture site.

*Autopsy*—*Macroscopic* Right. There was no infection, no discoloration, and the screws were bright. The proximal screw was embedded under 2 or 3 mm of dense healthy new bone. No fibrous tissue, no fluid. The distal screw was in the fracture site and was loose four plus. Serosanguineous fluid had collected in an area about  $1/3$  by  $1\frac{1}{2}$  cm.

*Left* Both screws were tight and were covered with a thin normal transparent fascia. No discoloration. No destruction of the tissue.

*Biochemical Analysis* No evidence of metal in soft tissue of the leg, liver or kidney.

*Histologic Examination*—*Vitalium* throughout.

Right distal. Marked periosteal thickening with moderate to marked degree of granulation tissue formation which is undergoing organization. Marked bone regeneration along line of fracture. General tissue reaction is marked.

Right proximal. Moderate periosteal thickening. Very slight degree of granulation tissue formation. General tissue reaction slight.

## CONCLUSIONS

(1) That it is impossible from macroscopic, microscopic and roentgenologic studies alone, to differentiate accurately the different reactions of soft tissue and bone to metals.

(2) That such reactions can be explained readily by biochemical study, based upon the behavior of metals ad seriatim in accordance with the laws of the electromotive force of metals.

(3) That electrical force is generated when different metals are placed in the tissues, by the creation of a battery, and the amount of current is proportionate to the difference in potential of metals at the two poles, the degree in which they are acted upon by the given electrolyte, and the distance between the poles.

(4) That pure metals alone are inert. Any action which takes place about them is a chemical reaction to body acids and has no electrolytic significance. Example—a battery containing two zinc plates only, cannot be "charged" electrically though the zinc may be taken into solution by the sulphuric acid.

(5) That those metals most widely separated in the E M F series create the greatest potentials, although only one of the pair may be acted upon chemically by the electrolyte.

(6) That when different metals are connected or coupled directly, there is a galvanic action between the poles which is increased in direct ratio with the resistance of the couple, and the rate of corrosion on the more electro-positive metal is accelerated. This is exactly analogous to a "short" in an ordinary wet cell.



(7) That any single metallic appliance made of galvanized iron, plated steel, or of metallic alloy containing a metal subject to the action of body fluids will cause some galvanic action

(8) That it is this electrolytic action which causes the formation of irritating metallic salt solutions in the local fluids. The reaction against it leads to the excessive proliferation of cellular and fibrous tissue which is protective, and the inhibition of growth of bone which is destructive

(9) That no different metals should be placed in a given patient and only pure metals, least subject to the action of the body fluids, should be used as far as possible. This explains why pure silver wire has been fairly well tolerated. However, when rigidity and tensile strength are necessary as in plates, screws, and nails, pure metals are too soft and alloys of the more resistant metals have to be used

(10) That in the selection of alloys to be used the relative position of metals selected in the E M F series is not essential as the properties of the alloy may be different from any of its components

(11) That in our opinion such alloys should not contain iron because iron is so subject to the action of the physiologic body salts. In all of our experiments those metals which contained iron showed large amounts of iron in the tissues adjacent and an excess of iron in the livers

(12) The alloy of least reaction that we have found is one called vitalium, which contains no iron and consists of cobalt, chromium and tungsten. There was no tissue reaction or bone change at the site of any vitalium screw though it was checked in many experiments with several different combinations of metals

(13) That any appliance that is plated with chromium is dangerous because chromium salts, which are extremely poisonous, are promptly liberated and readily concentrated in the liver. Once the plating is chipped or broken, a battery is immediately created. For this reason, unless chromium in an alloy can be shown to have had its potential completely lost in the new potential of the alloy in its changed position in the E M F series it might have the same effect as when used in plating

(14) That for this reason we suggest an alloy for bone work that is similar to vitalium in which vanadium may be substituted for the chromium, if such an alloy should confer the same degree of corrosion resistance and not be too brittle. However, following our experiments with the alloy vitalium, the constituents of its components seem to have lost their potential, as there was no trace of chromium liberated in any instance

We wish to express our appreciation to Drs. Milton Davis and D. A. Todd of the Nix Hospital Laboratories for their assistance in the roentgenologic studies and microscopic sections, to the San Antonio Analytical Laboratory for the biochemical study, to the Abbot Laboratories for the supply of nembutal for use in intravenous anesthesia, to the Austenal Laboratory of New York for making the screws of vitalium, and to the National Manufacturing Company of Sterling, Ill., for their kindness in supplying metal screws of all types

REFERENCES

- <sup>1</sup> Algave Reported at the 24th congres de chir , 1911
- <sup>2</sup> Cretin Recherches sur l'ossification et la reparation des os fractures Institut commercial, Le Mans
- <sup>3</sup> Cretin and Pouyanne Action de quelques metaux sur la consolidation osseuse Bordeaux chir , 4, 321, 1933
- <sup>4</sup> Doisy Th Lille, 1894
- <sup>5</sup> Duval Bull Soc de chir , 42, 611, 1916
- <sup>6</sup> Elsberg and Danborn Proc N Y Acad Med , 1906
- <sup>7</sup> Galfre Soc de phys et d'hist nat de Geneve, 47, 1930
- <sup>8</sup> Hey-Groves Brit Jour Surg , 1, 438, 1913
- <sup>9</sup> Jones and Lieberman Interaction of Bone and Various Metals Arch Surg , 22, 990, 1936
- <sup>10</sup> Lambotte L'intervention operatoire dans les fractures, 1913
- <sup>11</sup> Lambotte Soc de chir , November, 1932
- <sup>12</sup> Lange Ztschr f Orth chir , 1926
- <sup>13</sup> Le Fort Bull Soc de chir , 44, 733, 1918
- <sup>14</sup> Le Grand Normandie medicale, 293, November 1, 1923
- <sup>15</sup> Lemerle Th Paris, 1906-1907
- <sup>16</sup> Leriche and Policard Bull Soc de chir , 1145, 44, 1918
- <sup>17</sup> Potarca Presse med , 137, 1889
- <sup>18</sup> Rolland Th Paris, 1920
- <sup>19</sup> Rugh Jour Bone and Joint Surg , 722, 10, 1928
- <sup>20</sup> Trout ANNALS OF SURGERY, 717, 61, 1915
- <sup>21</sup> Zierold Arch Surg , 410, 1924

# INTERNAL FIXATION IN FRACTURES OF THE NECK OF THE FEMUR

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IN ANY discussion of fractures of the neck of the femur, differentiation must be made between those which occur in the central or narrow portion of the neck (so-called intracapsular fractures) and those which occur in the region of the trochanter. Since the time of Sir Astley Cooper, differentiation has been made as to location, and at that time it was presumed that fractures within the capsule did not unite by bony union, but that those external to the capsule united rapidly by bony union, as excellent functional results were secured. Regardless of accurate knowledge of over a hundred years' duration of the fundamental principles involved, there is still misunderstanding about fractures in this region. Within the past year I have seen fractures through the neck and trochanter exhibited before a well known national association on two occasions, without differentiation, and within the past 10 years on more than one occasion before this association. Differentiation must also be made between complete central fractures of the neck of the femur and impacted central fractures, as the latter will unite without difficulty, and a good functional result will be obtained if the impaction is not disturbed.

In 1932, I<sup>1</sup> demonstrated that trochanteric fractures were of more frequent occurrence than complete central fractures and that impacted central fractures were not infrequent, after reviewing the records of 688 fractures of this region of which 495 were fresh fractures which may be enumerated as follows

		Over 70 Yrs of Age	
Trochanteric	229	108	average age 78 1%
Complete central	214	78	average age 74 6%
Impacted central	52	19	average age 79 5%

Thus, impacted fractures of the neck of the femur and intertrochanteric fractures constitute more than half of the fractures presented above (56.7 per cent), in which union may be expected in practically 100 per cent, if only approximate anatomic apposition is maintained. Only in central fractures of the neck of the femur (43.3 per cent) is there any doubt as to securing osseous union. The average age of trochanteric fractures as noted above is higher, and of even more frequent occurrence, in elderly individuals (70 years or older) than central or intracapsular fractures.

Therefore, especial emphasis must be placed upon differentiating between the location and characteristics of (1) complete, central or intracapsular, (2) impacted central fractures of the neck of the femur, and (3) fractures in

the trochanteric region, in any discussion of this most important subject. Regardless of our modern methods of diagnosis, the older surgeons who classified these fractures as intra- and extracapsular, had a better understanding of fractures of this region than is often manifested today.

As stated above, complete, central fractures of the neck of the femur constitute only 43 per cent of fractures in and about the neck and trochanters. This in no way disparages its importance or frequency of occurrence as fractures of this region are quite numerous. Prior to 1904, it was considered that central or intracapsular fractures did not unite by osseous union. At this time, Royal Whitman described the abduction method of reduction with fixation by a plaster of paris spica and demonstrated that osseous union could be secured. This procedure was soon adopted by the orthopedic surgeons of America and it was thought that the problem had been solved as a very high percentage of excellent functional results were reported. This was undoubtedly due to the fact that many impacted and trochanteric fractures were included in the analysis of cases, as Whitman himself did not clearly differentiate. However, as time elapsed and discrimination was made as to location and characteristics, a committee of the A O A, in 1929, made a very careful survey, excluding all except complete central or intracapsular fractures, and found that osseous union was secured in 50.4 per cent of 201 fractures from various well known clinics of America.

Obviously, the Whitman method was the first and possibly the greatest advance that has ever been made in the treatment of this fracture, but still left much to be desired, as long fixation and confinement were required before osseous union could be determined, often with permanent damage to the hip and knee or accompanied by serious constitutional complications.

The frequent occurrence of nonunion in complete central or intracapsular fractures is due to the physiologic status of the region, which has been described in detail in former contributions. The more important factors may be briefly mentioned, as: Impairment of circulation to the proximal fragment, osteoporosis, inaccurate reduction, shearing action of weight bearing, the deleterious action of the joint fluid on callus, and deficient blood clot.

In any treatment of fracture of the neck of the femur, accurate reduction is essential, but not until recently could this be determined by the roentgenogram, as only the anteroposterior view was possible. The lateral view is now obtained by the curved cassette and other methods, so that more exact relations can be determined. This development has undoubtedly been a great advance in the treatment of fractures of this region, however, I have observed, after taking both views, that reduction is accomplished by the Whitman method in practically every instance, so that I do not believe that this factor alone accounts for the many failures after this treatment.

Internal fixation by nails, screws, and pegs of this fracture is by no means new, as the first report was made by von Langenbeck<sup>2</sup> of one case treated by this method in 1850. Successful results were reported by Nicolaysen<sup>3</sup> and others prior to the advent of the roentgen ray. E. D. Martin and A. C.

King,<sup>4</sup> in 1922, and Thomas,<sup>5</sup> in 1921, report excellent results, using wood screws as a means of internal fixation. At this time internal fixation was not uniformly successful either because of inaccurate reductions or because of lack of dexterity on the part of the surgeon in introducing the means of fixation. In consequence, this method fell into disuse with the exception of a small number of surgeons who were probably more expert in properly placing internal fixation, notably E. Denegre Martin of this Association. Recently his end-results were reviewed by Dr. Brewster,<sup>6</sup> of New Orleans, who added 21 cases of his own treated by this method; he reports 89.68 per cent successful results in a series of 53 cases. The more recent literature abounds with various ingenious methods of obtaining internal fixation.

Smith-Petersen,<sup>11</sup> in 1925, introduced a three flanged nail which he placed through the neck of the femur by means of a wide exposure of the hip joint, and to him is undoubtedly due the credit for reviving interest in internal fixation which is rapidly becoming the method of choice. This nail has the advantage of securing fixation and preventing rotation. Many who have adopted this procedure believe that the operation is too formidable in the aged, and are applying the nail by inserting it through an incision over the trochanter, so-called "blind nailing," as it had been employed by other surgeons prior to Smith-Petersen. Local anesthesia may be successfully employed if indicated or desired. It has been proved that just as accurate fixation can be accomplished and maintained in this manner, and without any appreciable surgical shock. Since this method has become popular, other means of internal fixation have been employed, as Multiple spikes (Gaenslen<sup>7</sup>), two pins (Knowles<sup>8</sup>), two drills (Rowlette, Haslem, Siegart, Morris, Key<sup>9</sup>), three pins threaded in outer half with a small nut (Moore<sup>10</sup>). All of these have two or more pegs which traverse the neck and head so as to prevent rotation of the head. In some, the head and neck of the femur become a veritable pin cushion. Excellent results have been reported by all of these methods, the problem is apparently a question of efficient internal fixation. The amount of foreign material, if pins or spikes are used, is approximately the same as the Smith-Petersen<sup>11</sup> nail, but has the advantage of being much less expensive.

No one has been a stronger advocate of the Whitman procedure than I, but after seeing the results of Smith-Petersen and others, I have come to the conclusion that internal fixation not only gives a higher percentage of excellent functional results and firm osseous union, but also materially decreases the time in which union is secured, so that weight bearing and walking without support is obtained in from four to six months as compared to six to 12 months by the Whitman method. Also function in the knee and hip is materially conserved, and permanently restricted motion is exceedingly rare. The mortality has been materially decreased by the less extensive means of immobilization and the shorter time of confinement to bed.

My colleagues and I have employed the three-flanged nail in 35 cases of complete, central, or intracapsular fractures of the neck of the femur. In 11, the procedure as described by Smith-Petersen was employed, which consisted

in a complete exposure of the hip joint and trochanter, in 24, the nail was inserted through a lateral incision with "blind nailing." The Smith-Petersen technic has been entirely discarded, as so-called "blind nailing" is a less extensive surgical procedure.

*Operative Technic*—The present technic of insertion may be described as follows. Reduction is uniformly accomplished by the well known Whitman abduction method, so that, usually, no roentgenogram is made at this time. After reduction, abduction is reduced to about  $120^{\circ}$  so as to facilitate insertion of the nail. An incision approximately four inches in length is now made over the lateral aspect of the greater trochanter and upper two inches of the shaft exposing the lower half of the greater trochanter and upper two inches of the shaft exposing the lower half of the greater trochanter and upper one

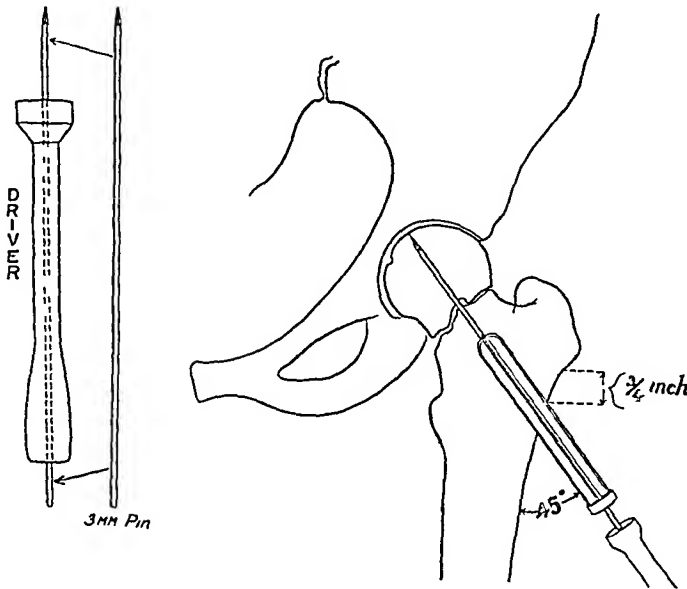


FIG. 1—Graphic illustration of Johansson method of securing proper direction of nail. The author's tunnel driver greatly facilitates application.

or two inches of the shaft. A 3 Mm steel wire peg is then placed into an ordinary chuck drill, and the sharp end of the wire inserted into the center of the shaft about three-quarters of an inch below the trochanter. Great care must be taken that the wire drill makes an angle with the shaft of about  $45^{\circ}$  and is angulated forward about 10 to  $15^{\circ}$  to conform to the normal anterior deviation of the neck. The wire is now drilled about two inches in this direction, after which roentgenograms are made in both planes as above described, which will confirm reduction and the exact direction of the wire drill. If reduction has not been accomplished, a second attempt can be made, but this has not been necessary in any case, also if the wire is not accurately placed, other attempts can be made until the desired direction is obtained. If reduction and direction of the wire is satisfactory, the wire is drilled into the head of the bone to within one-quarter to one-half inch of the joint, depending on the length of the proximal fragment. This is confirmed by the

roentgenogram The protruding portion of the wire is now measured by placing a wire drill of the same length parallel with the protruding portion,



FIG 2—(Case 1) Nail in position, firmly securing fragments



FIG 3—(Case 1) Solid bony union after removal of nail. Note a small piece of metal remaining in the head, a portion of the end of the tunnel. This complication should not occur if heavier material is used, as modified by the author.

and a nail of exact length selected. I employ a modification of the three-flanged Smith-Petersen nail with a steel tunnel through the center, which is slightly larger than the wire. The nail is then threaded on the wire. A driver



FIG 4—(Case 2) Anteroposterior view, nail in position

FIG 5—(Case 2) Lateral view, nail in position

with a tunnel in the center is now threaded over the wire and the nail driven through the neck and head by the aid of a heavy mallet (Fig 1). The wire is removed and the driver placed over the trochanter, and the instrument

tapped a few times with a mallet so as to closely approximate the fragments. Roentgenograms are now made to confirm the position and the wound closed. The hip can be freely moved in the socket. Roentgenograms should not consume more than 15 minutes, and should be developed and returned to the



FIG 6—(Case 3) Woman age over 80 nail in position



FIG 7—(Case 3) Firm bony union after removal of nail at the end of seven months

operating room in five minutes. The entire procedure requires not more than 30 to 40 minutes. Unless there is complete cooperation of the roentgenologist, the procedure is unnecessarily prolonged. When this method was first adopted, we had great difficulty in securing proper direction of the guide



FIG 8—(Case 4) Bending of wire in the head of the bone, which is a serious complication and will not occur if stronger material is used



FIG 9—(Case 4) End result in Case 4 after employing the nail

wire, but with experience, and by following, in detail, the above technic, we have become more dexterous.

No originality in the use of the nail and wire is claimed as the method was first described by Johansson,<sup>12</sup> of Sweden, who employed a Kirschner wire and a tunnel through the nail, but as the small flexible wire may bend



when it strikes the head, there is danger that the wire may curl itself within the head, making its removal impossible without much damage to the patient and chagrin of the surgeon, as occurred in one case as illustrated in Fig 8

After operation the limb is placed in a Hodgens' splint. At the end of three weeks, roentgenograms are made in order to confirm the position, which we have always found undisturbed. Motion in the knee is instituted at the end of four weeks, when the patient may be removed to his home. At the end of three months, walking is instituted without weight bearing, and at the end of four months, weight is borne on crutches. At the end of five or six months, crutches are discarded if union is firm, as demonstrated by the roentgenogram, which should show trabeculae transversing the line of frac-

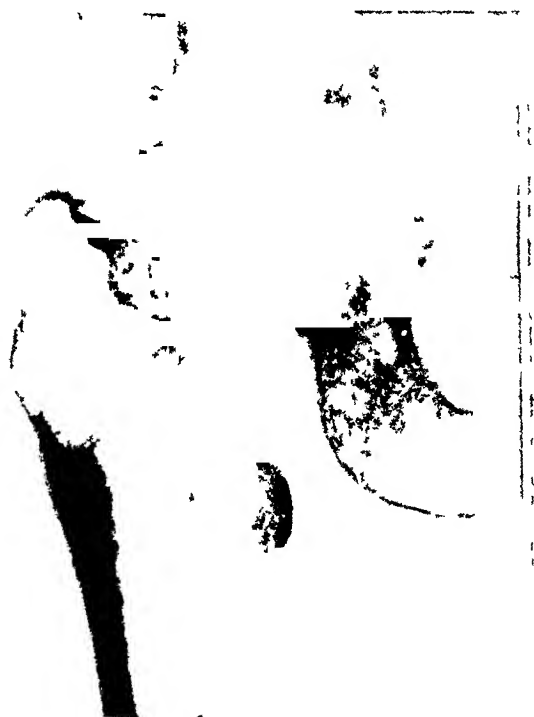


FIG 10—(Case 5) Apparently solid bony union but with possibly septic necrosis of the head. Time alone will determine the functional result.



FIG 11—(Case 6) Destructive changes in the head evidently due to extreme atrophy.

ture. Undoubtedly it is possible that function may be assumed earlier, but the physiologic status in this location is such that firm union is always slow.

Some surgeons, as Thornton of Atlanta, do not remove the nails. Since Lane plates and other metals used for internal fixation have been known to cause complications years later, we have removed the nail at the end of six months. This can be accomplished under local anesthesia with practically no postoperative disability. The nail is loose in a high percentage of cases, and can be extracted with ease. As is well known, pressure by the metal peg usually causes bone atrophy, therefore, a circular tunnel is usually formed about the nail with an accumulation of seropurulent serum. Cultures have all been negative. In only two instances was the nail tightly fixed by surrounding bone.

This method has been applied in 35 patients, six of whom died before end-results could be determined. None of these deaths was immediately post-

operative Seven are of less than four months' duration, and three have not returned for further observation Nineteen have been under personal observation for a sufficient period to determine the degree of osseous union Of these, every one has secured osseous union The knee joints have a normal range of motion, and there is practically normal function of the hip in 17 cases In two, even though osseous union is undoubtedly present, there have been late changes in the head In one, there is erosion, possibly from atrophy which may have been caused by too close approximation of the nail to the articular surface However, this patient died at the end of two and one-half years from hemiplegia and thrombocytopenic purpura One complains of definite arthritic symptoms with pain and disability, but there is a firm osseous union The roentgenogram demonstrates that the head is denser than the surrounding bone This is thought to be an absolute indication that the head is dead or has become an aseptic sequestrum However, the head of the bone may not have sufficient blood supply to undergo the normal osteoporosis that is a physiologic process in the fragments of every fracture, although there may be sufficient blood supply to keep the head alive This has been proved by microscopic examination of some of the heads removed at operation which were thought to be dead, but were found to have a sufficient blood supply for nutrition but not for the physiologic process of callus formation, or osteoporosis

In four cases, only ten months to one year has elapsed since treatment, but the roentgenogram and function of the limb is so conclusive of normal osseous structure of the bone and joint that little doubt remains as to the ultimate end-result The remaining 15 have been observed for one or more years, however, all cases will be closely followed for two or more years to determine even a remote possibility of subsequent arthritic changes

#### CONCLUSIONS

In conclusion it is desired to emphasize

(1) The utter impossibility of securing accurate statistics regarding any method unless there is a differentiation as to location

(2) That internal fixation of the neck of the femur gives by far the highest percentage of excellent functional results in the shortest period of time, which is of vast importance in elderly individuals

(3) In only 43 per cent of fractures about the upper extremity of the femur is there difficulty in securing union, namely Complete, central or intra-capsular fractures of the neck of the femur Fifty-seven per cent are either in the region of the trochanter or impacted, in which union may be expected with rare exceptions

(4) The presence of metal delays union, but the fixation attained apparently overcomes this objection and greatly enhances the normally delayed physiologic process

#### REFERENCES

- <sup>1</sup> Campbell, Willis C Fractures in and about the Neck of the Femur Minn Med, 15, 654, October, 1932

- <sup>2</sup> von Langenbeck. Verhandl d deutsch Gesellsch f chiu Seventh Congress, 1, 92, 1878
- <sup>3</sup> Nicolaysen, J. Lidt om Diagnosen og Behandlingen av Fr colli femoris Nord Med Arkiv, 8, 1897
- <sup>4</sup> Martin, E. D., and King, A. C. Preliminary Report of a New Method of Treating Fractures of the Neck of the Femur New Orleans Med and Surg Jour, 75, 710, 1922-23
- <sup>5</sup> Thomas, T. T. Fixation by a Wood Screw without Arthrotomy in Certain Fractures of the Neck of the Femur Am Jour Surg, 35, 292, September, 1921
- <sup>6</sup> Brewster, W. Rogers. Internal Fixation in Fractures of the Hip Am Jour Surg, 30, No 3, 420-426, December, 1935
- <sup>7</sup> Gaenslen, F. J. Fractures of the Neck of the Femur J A M A, 107, 105-114, July 11, 1936
- <sup>8</sup> Knowles, F. L. Fractures of the Neck of the Femur Wisconsin Med Jour, 35, 106, February, 1936
- <sup>9</sup> Rowlette, Haslem, Siegert, Morris, Key. Results Obtained by Subcutaneous Pinning of Fractures through the Neck of the Femur J A M A, 107, No 20 November 14, 1936
- <sup>10</sup> Moore, Austin F. Fractures of the Hip Joint, A New Method of Treatment Intern Surg Digest, 19, 323-330 June, 1935
- <sup>11</sup> Smith-Petersen, M. N., and von Gorder, Geo. W. Intracapsular Fractures of the Neck of the Femur Arch Surg, 23, 715-759 November, 1931
- <sup>12</sup> Johansson, Sven. On the Operative Treatment of Medial Fractures of the Neck of the Femur Acta Orthop Scandinav, 3, 362, 1932
- <sup>13</sup> Campbell, Willis C., Orr, H. Winnett, and Osgood, Robert B. Report of a Commission Appointed by the A O A. to Study End-results of Intracapsular Fractures of the Neck of the Femur Jour Bone and Joint Surg, 12, 966-969, 1932

# DISCUSSION OF THE PAPERS OF DOCTORS STRICKLER, VENABLE, AND CAMPBELL

DR W. R. BREWSTER (New Orleans, La.) —I wish to discuss chiefly Doctor Campbell's paper on internal fixation of the neck of the femur. It was my great privilege to be associated with Dr. E. Denegre Martin in his work on internal fixation and I have followed his work since his death. His first case was operated upon in 1920 and, therefore, antedates many of the more recently reported cases and methods of internal fixation. We have been successful with it and I should say, in view of Doctor Venable's presentation, that the material used in this method has been a simple wood or hardware screw, No 8, three inches long (sometimes three and one-half inches), and we have roentgenograms which show these screws still in position after eight years without any effect on the bones, so far as the metal used is concerned. With your permission I shall briefly review the procedure as we employ it.

*Operative Procedure*—The patient is placed on the table and the leg held by an assistant in slight abduction and internal rotation of about 35°. This throws the neck of the bone on a horizontal plane. It is to be remembered that the long axis of neck of the femur is at a right angle to a plane passed through the subtrochanteric line. With the drill upon the prominence of the anteroposterior curvature of the bone, it is introduced parallel to the long axis of the neck on a horizontal plane, the drilling being continued to the line of fracture and not into the head fragment. At that time a roentgenogram is made to see if the drill is in proper position. If not it can be taken out and redirected. The drill is then removed and the screw introduced, the threads engaging the head fragment so that the head acts as a nut on a bolt and is drawn to the shaft fragment as the screw is "driven home." The first screw is not driven home but is left sticking out as a guide for the introduc-

tion of the second screw which is placed parallel to it, then both are fixed tight, the two screws preventing rotation

We do not make it a practice to remove the screws. Roentgenograms, at times, make it appear that the screws are backing out, but that is not the case, as in subsequent ones of the same case the screws will be seen to protrude the same distance without change from year to year. Some have remained *in situ* for as long as eight years without any apparent detriment to the bone or the patient.

DR JAMES S. SPEED (Memphis, Tenn.) —Doctor Campbell has shown that the percentage of solid bony unions obtained in central fractures of the neck of the femur has been increased from 50 to 55 per cent to approximately 80 per cent by the method of internal fixation by means of the Smith-Petersen nail. We have not as yet reached any definite conclusions as to why this marked improvement should have occurred. In the early cases treated by this method, the hip joint was exposed by a Smith-Petersen incision and completely visualized. In all these cases the Whitman manipulation was performed, and it was clearly seen that a satisfactory reduction of the fracture was obtained in practically all cases.

The same method of reduction is utilized in conjunction with the methods of internal fixation. Consequently, we have not changed our method of reduction. It is well known that in central fractures of the neck of the femur the capital fragment is deprived of its major source of blood supply. This disturbance in blood supply is also present, in the same manner, in cases treated by the Smith-Petersen nail.

Immobilization of the cases by the Whitman method in a plaster spica, while it is relatively secure, unquestionably permits a certain amount of movement at the site of fracture. It has been shown by Santos and others that aseptic necrosis of the head of the femur is not uncommon in central fractures of the neck of the femur, occurring in about 30 per cent of the cases. In those cases in which aseptic necrosis of the head occurs, nonunion results. What then has the Smith-Petersen nail added to the Whitman method? Other conditions being the same, it must be a more secure immobilization of the fracture, preventing slight movement between the fracture surfaces.

It is felt the more stable or more secure immobilization permits early growth of the capillaries across the fracture line, thus producing earlier revascularization of the head before aseptic necrosis occurs, and this is the explanation of why the results are better by means of internal fixation than by the older methods of treatment.

DR H. EARLE CONWELL (Birmingham, Ala.) —Doctor Campbell has presented a problem which is interesting bone surgeons more, recently, than ever before. The main reason, I believe, for this interest has been on account of the poor results, such as nonunion and even mortality, which we have encountered by treating fractures of the neck of the femur by the Whitman abduction method and methods which demand bed treatment. The Fracture Committee of the American Academy of Orthopedic Surgeons is now attempting to analyze the results of the open method and internal fixation treatment of fractures of the neck of the femur. It is hoped that within the next two or three years after approximately a thousand cases have been reviewed that definite conclusions can be made concerning such type treatment.

Taken for granted that even though we will not obtain any more union in fractures of the neck of the femur by internal fixation of such fractures, I believe that it is justified because

- (1) There will no doubt be a lessened mortality
- (2) The mental attitude of the patient is entirely changed. As a matter of fact, the patient feels as if he had a few more years of normal life and activity following such an operation. It is necessary for a surgeon to see only one such instance of the mental attitude of a patient who has had internal fixation of a fractured neck of the femur to become convinced of their optimism.
- (3) The economic status is improved, such as lessening of the period of hospitalization and cost of the nursing care.
- (4) The disabilities about the hip and knee are seldom seen, as in the plaster spica treatment, and last, but not least, the patient is out of bed, sitting up, within a week or thereabouts following the operation.

Regarding the type of internal fixation, this depends entirely upon the method with which the surgeon is familiar.

Proper reduction is, of course, an important factor. Before the lateral view of the fractured hip became popularized I believe that we could account for at least 10 per cent of our nonunions as the result of improper reduction. I use the Leadbetter-Whitman technic in reducing these fractures. It is imperative that a lateral view always be made in a fracture of the hip before and after the reduction and operation. The lateral view can be simplified at the time of operation by flexing the thigh at a right angle to the hip as well as abducting the thigh about 15 or 20° from the midline.

DR JOHN A. CALDWELL (Cincinnati, Ohio) —I wish to discuss Doctor Campbell's paper because I am particularly interested in the method of open fixation. Since January, 1934, this has been our method of treatment exclusively in intracapsular fracture of the femur. During that time we have treated 50 cases. Of these 31 were of the neck, and 19 intertrochanteric. As Doctor Campbell explained, the intertrochanteric cases offer no problem so far as union is concerned. All but five cases were from the Fracture Service of the Cincinnati General Hospital, where undernourishment and alcoholism played a part in mitigating against a favorable result. Our cases have not been selected but have been taken as they came. Fourteen of the patients have died, but not as the result of the operation. One died on the day of operation from embolism, and another died two days later from pneumonia, the others died from two to four weeks postoperatively, but all died in the hospital. Twenty of the fracture of the neck cases have survived, and of those, at this time, we have five which have failed to unite. In other words, we do not feel that this open fixation is the answer to the question of union or nonunion, but it does make a great difference in the comfort of the patient and his ability to survive the ordeal that accompanies this sort of fracture. Five have not yet united, some have not been pinned long enough to say whether they will unite. We have used the Austin Moore pin, and we have adhered to the methods Speed insists upon, an accurate reduction and fixation by the pins holding the fragments as they belong. Probably the most favorable case we had was a robust, cooperative woman of about 49, who, with absolute reduction and everything apparently favorable, at the end of four months showed the head absorbing and a portion of the neck gone. While we feel that this method does make a great difference in the comfort and well being of the patient, we do not feel that we can say anything about its answering the question of union and nonunion in a fracture.

DR R. ARNOLD GRISWOLD (Louisville, Ky) —I think that there is no doubt but that internal fixation of the hip has come to stay, even if it does

not give a higher percentage of union. At the Louisville City Hospital, we have undernourished patients and also an admittedly inadequate nursing service. Our mortality in all fractures of the hip in patients over 50 years of age was formerly 40 per cent. Internal fixation has reduced that to ten per cent. I believe the question will be solved if we use proper mechanical and surgical principles in reduction. The fracture should be reduced in slight coxa valga, bringing the weight bearing line through the head more directly onto the shaft of the femur. The pin should be in the center of the head and as nearly parallel to the shaft as possible. This gives a straight weight bearing line along the pin and when absorption occurs in the neck, muscle pull and weight bearing cause the fragments to slide together along the pin, maintaining reduction. I am not prepared to give any statistics on the percentage of bony union. We have had three cases of nonunion, each of which can be explained by poor reduction and improper placing of the pin. We have used the method described by Doctor Campbell, but we have used from two to four wires, since I have not been able to accurately insert a single wire into the desired position every time. We pick out the most eligible wire, as determined roentgenologically, and drive the nail over that wire, pulling the others out. This method of treatment has solved many of our problems and I am sure we will continue to use it.

DR FRANK D DICKSON (Kansas City, Mo.) —For better or for worse, the facts are. That for the past 10 or 15 years there has been a vast increase in fixation of fractures by nails, screws, and various other gadgets. The Fracture Committee of the College of Surgeons worked for several years with the Bureau of Standards in Washington to evolve bone plates and screws of a tensile strength which would reduce their breaking, which occurs often enough to be a menace, to a minimum.

No investigation, however, has been made to determine the effect of metals on tissue, particularly bone, which has arrived at any practical result until Doctor Venable carried out his research. I had the privilege of going over Doctor Venable's work at San Antonio and feel sure that he has found the answer to the question of what causes irritation about metal placed in bone, which irritation means that every screw put into a bone becomes loose at varying periods of time. You saw the evidence of irritation, in the illustrations which Doctor Venable showed, in all experiments except those in which the vitalium was used.

The practical point of Doctor Venable's paper, I think, is that he has suggested a metal which he has proved does not irritate bone and so does not become loose. This should mean that we will have available screws, nails, plates, or whatever form of fixation we wish to use to fasten bone, which will hold and give us a great deal more satisfactory and more certain fixation than we have had with metals which have been used up to this time. I think Doctor Venable's findings are very important since we may then have in our armamentarium a metal which will be nonirritating to bone.

DR WM S GOLDSMITH (Atlanta, Ga.) —Like Doctor Strickler, I am a general surgeon, having a certain flair for orthopedic surgery, but today this practice is limited to acute bone injuries.

The enthusiasm following the brilliant work of Mr Lane's method of plating long bones with metal plates and metal screws, 25 years ago, inaugurated various means of securing union of the larger long bones in cases of vicious union and nonunion in old fractures. Doctor Venable's contribution is most timely and extremely interesting.

I have a case of nonunion of the tibia in which a Lane plate, three inches long with four screws, was introduced 25 years ago. It is still in the leg of a prominent physician of Atlanta.

DR CHARLES S VENABLE (closing) —I probably did not make it as clear as I should have that the metals used were all different, and were employed for the purpose of creating disturbance. Among them are the vitalium screws of which I have spoken. The absence of effect on the bones is notable. There is apparently proliferation about them and not destruction. One notes, roentgenologically, the absence of reaction in the bone that was apparent with all the other screws, and the total lack of tissue reaction around the screws.

Using two steel or similar metal screws is like putting two lead plates in a battery and then trying to bring up the battery when nothing happens. Body fluids in different individuals are different in quality, which has much to do with their potency as an electrolyte. Most of the metals, in the many forms we have used previously, will cause a definite reaction due to electrolysis. This in many instances has not been sufficient to defeat the purpose, yet this reaction, in far too many instances, is so great that osteosynthesis is interrupted. The objective is to use only similar metals which are so resistant to body fluids that there will be no electrolytic force created and, therefore, no bone destruction or tissue reaction.

DR WILLIS C CAMPBELL (closing) —I wish to thank Doctor Speed and Doctor Dickson for bringing out certain points which were in the text of the paper but which I did not have time to discuss.

As to end-results, we have had 19 cases which we have followed through. All 19 have shown solid bony union. Two of the cases have some changes in the heads later but were solidly united. Lawson Thornton, of Atlanta, has shown the same percentage in 30 cases, and Brewster, of New Orleans, showed the same in 89 per cent, with the E. Denegre-Martin technic. I do not wish to imply that end-results will always be 100 per cent, but I do believe they will be materially improved by internal fixation. Union occurs in a much shorter period of time than by the Whitman method, and if we can secure union in a shorter period of time we will have less destruction in the heads later, and a higher percentage of excellent results. There is more confusion regarding this at the present time than there was among the older surgeons who employed the terms intra- and extracapsular fractures of the neck of the femur.

In 1930, an analysis was made of the end-results of the Whitman treatment of fractures of the neck of the femur from data collected from various clinics in America. This was 26 years after the treatment was first instituted. At the present time the Fracture Committee of the American Academy of Orthopedic Surgeons is studying the end-results of treatment by internal fixation. This will not take as long as it took to determine the results of the Whitman treatment, and I believe we will soon know the relative value of the various procedures.

# CONGENITAL LYMPHATIC DISEASES—LYMPHANGIOMATA

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BECAUSE of the confusion in the minds of many of the medical profession regarding many phases of the various lymphatic disorders, I have attempted a discussion of their developmental explanation, as well as a report of a group of such conditions which have come under our observation

Just as in many other congenital disorders, if their embryology is understood, it gives the surgeon a sense of security, not only in the diagnosis but in their management It seems an appropriate introduction to this paper to quote Dr James E Thompson,<sup>1</sup> who, in 1919, said "Nothing can be more fascinating than a study in which truths stand suddenly revealed by a new arrangement and correlation of observations which individually are of mere academic interest It is like finding new beauties in a picture or hidden meanings in a beloved book Happy is the man who sees and understands, and unhappy he who is blind to the path beyond the open door, whose windows remain always barred to the universe

"Human anatomy, viewed merely from the standpoint of bones, muscles, nerves, viscera, *etc*, is perhaps one of the most difficult of all studies to learn and retain in one's memory If taught without comparison between the anatomic structures of man and those of other vertebrates the study becomes a dull grind and a hopeless presentation of facts without meaning or purpose Each structure and organ has its own history, which is inseparably connected with that of similar structures in the lower animals, and the parallel histories of these organs in each species form, as it were, a contemporary history of every species through all eternity Viewed from this aspect, human anatomy becomes a fascinating and romantic study, in which reason is added to mere fact and purpose takes the place of coincidence"

*Development of the Lymphatic System*—The present accepted theory as regards the development of the lymphatic system has been an evolutionary affair with many changes The generally accepted facts at the present time have resulted from investigations and observations of Sabin,<sup>3</sup> Huntington and McClure largely These theories are expressed briefly by quoting from Keith,<sup>2</sup> who says "Recent enquiries by American embryologists, especially by Huntington and McClure, have thrown quite a new light on the origin of the lymphatic system They have established that the formation of lymph vessels begins at definite centers and from such a center vessels spread outwards vascularize and drain a definite area If the starting center is excised then there is no outgrowth and the vessels from neighboring areas invade and



dian the one thus deprived. The greatest and earliest center is situated in the angle between the jugular and subclavian veins, where the termination of the thoracic duct is afterwards formed. By the end of the eighth week the capillary network of lymph vessels was fused and formed the extensive lymph sac. In the third month outgrowths from the jugular sac on each side of the neck spread and invade the tissues of the neck, head and arm—all save the central nervous system and voluntary muscles. These are not drained by the lymphatic system. The great lymph sacs are merely tem-

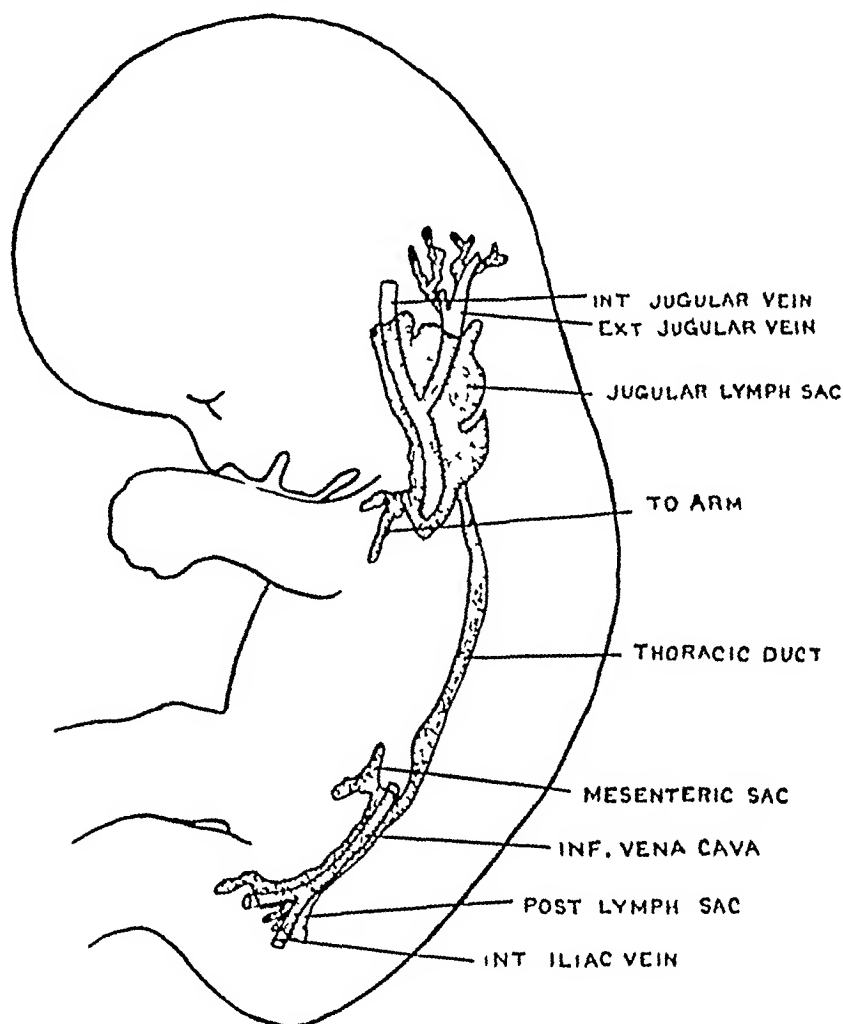


FIG. 1.—Centers of lymphatic development in embryo

porary structures, then cavities are filled by reticular lymphoid tissue produced by the lymphatic endothelium which lines the sacs. As soon as formed, the jugular lymph sac effects a union with the jugular vein, the orifice being guarded by valvular folds.

"Another pair of lymph sacs appear in the pelvis—related to the corresponding iliac veins, into which they are first open. From the pelvic or iliac sacs outgrowths invade the hind limbs and tissues of the pelvis and buttocks. In the mesenchymal tissue in which the dorsal aorta is embedded there appear a series of endothelial-lined lymphatic spaces, which become united and place the posterior or iliac sacs in communication with the jugular sacs. In

this way two thoracic ducts are formed at the end of the second month. Two other retroperitoneal centers appear, one at the root of the superior mesentery artery, from which arises the system of vessels which drain the

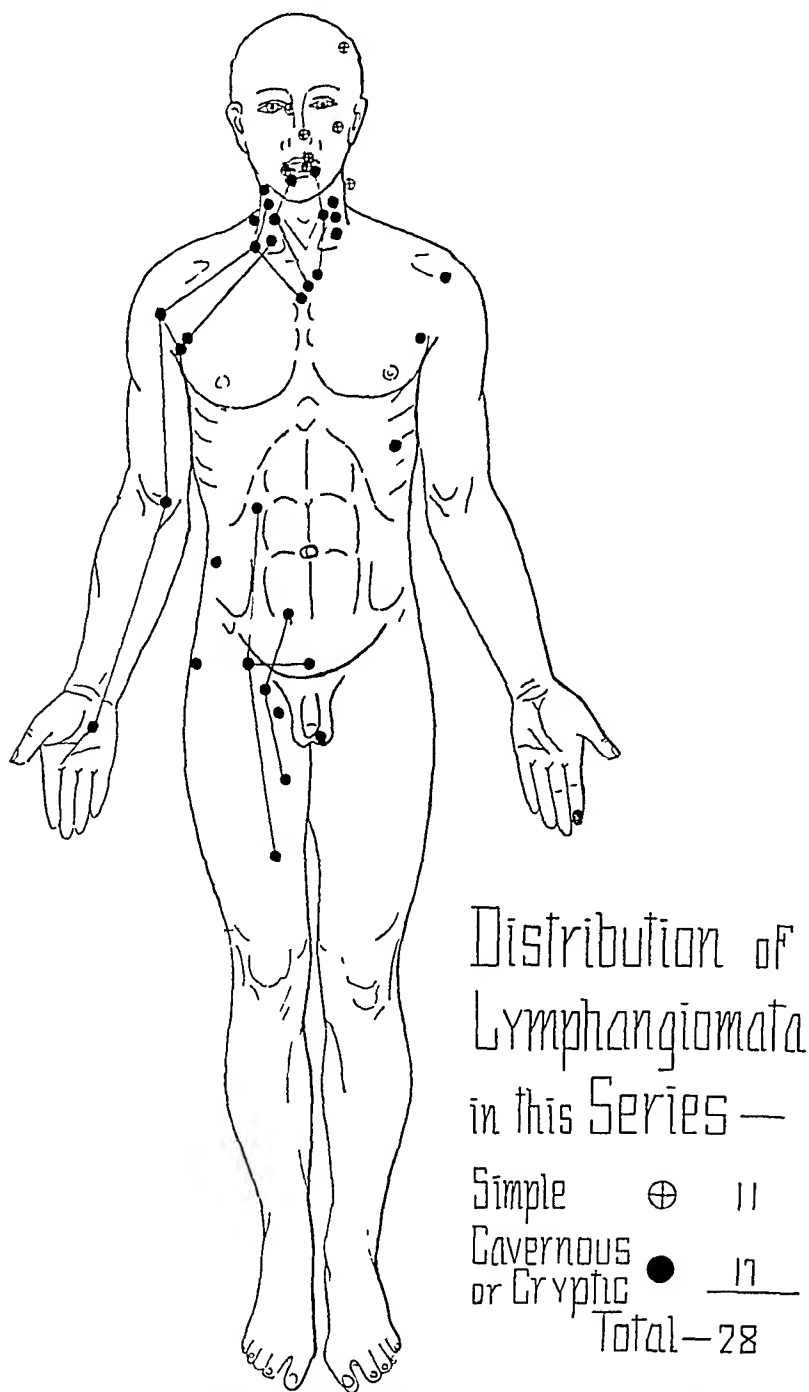


FIG 2—Location of lymphangiomata in our series of cases

alimentary tract, the other, to give origin to the receptaculum chyli. The lymphatic system is just as much a 'closed' system as is the haemal system, everywhere its walls are lined with endothelium. Nowhere does it communicate with 'tissue spaces'."

# LYMPHANGIOMATA

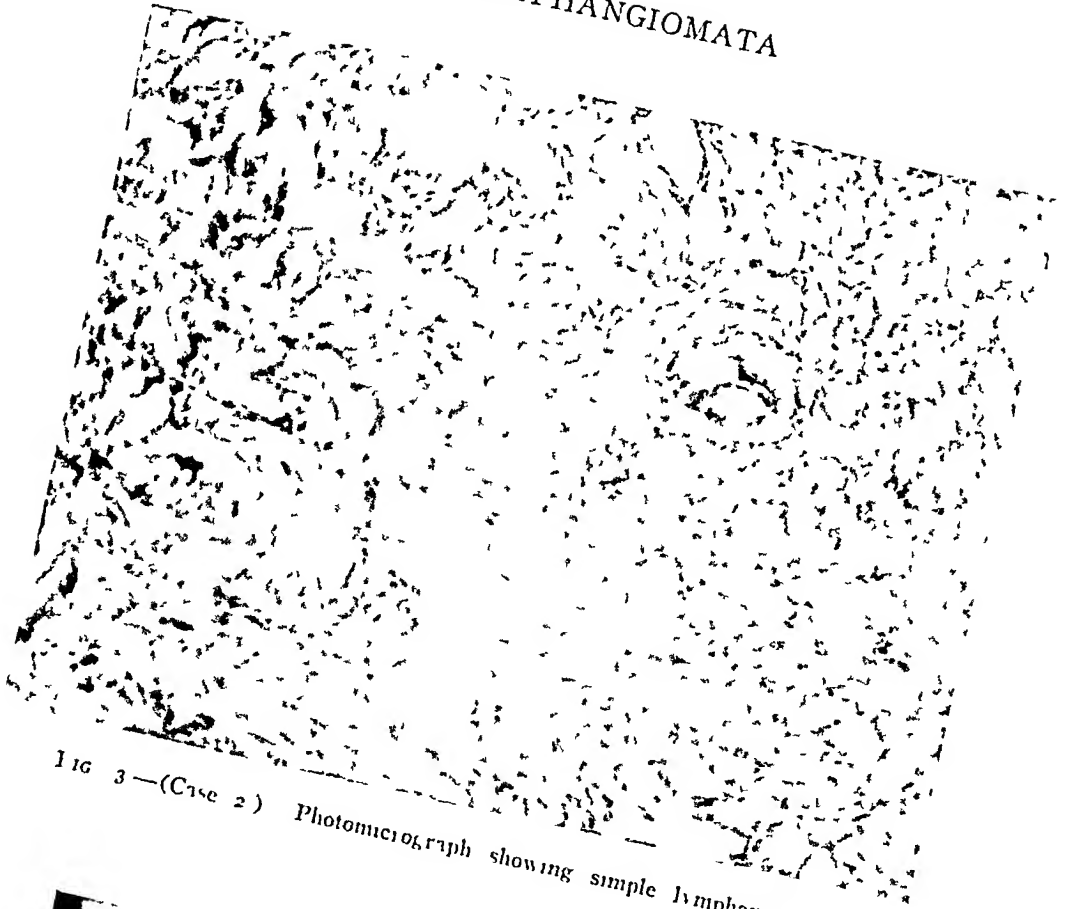


Fig 3—(Case 2) Photomicrograph showing simple lymphangiomata



Fig 4—(Case 13) Following radium therapy

Sabin says "Lymphatics are modified veins. They are vessels lined by an endothelium which is derived from the veins. They invade the body as do blood vessels, and grow into certain constant areas, their invasion of the body is, however, not complete for there are certain structures which never receive them. The lymphatic capillaries have the same relation to tissue spaces as have blood capillaries. None of the cavities of the mesoderm, such as the peritoneal cavity, the various bursae and serous cavities form any part of the lymphatic system. The lymphatic endothelium once formed is specific. Like blood vessels the lymphatics are for the most part closed vessels."



FIG 5—(Case 16) Showing diffuse cavernous lymphangioma of chest wall



FIG 6—(Case 16) Photomicrograph showing cavernous lymphangioma

With this important knowledge provided for us we are in a more advantageous position to understand and treat our clinical cases of lymphatic abnormalities.

The important lymphatic disorders to be considered may be outlined as follows:

- (1) Lymphangiomata
  - (a) Simple or capillary
  - (b) Cavernous
  - (c) Cystic
- (2) Elephantiasis \*
- (3) Chylous ascites, chylothorax, chyluria, chylopericardium, and the so called pseudochylous conditions.

LYMPHANGIOMATA—Generally speaking, the three varieties of lymphangiomata have a common origin.

\* The consideration of Nos. 2 and 3 will be taken up in a subsequent communication.

The *Simple Lymphangiomata* are of the least importance, occurring often superficially, being easily diagnosed, and easily removed. Still, the explanation for their existence probably differs little from the other varieties.

The *Cavernous Lymphangiomata* consist of a framework of connective tissues in which are numerous single and communicating lymphatic cysts. There are many anastomosing channels and often irregular masses of lymphocytes, lymph nodes and lymph follicles, and not infrequently one sees neoplastic blood vessels in great numbers. Where the vascularity is quite great, the term hemangiolymphangioma is applied to them. These tumors are often found in the neck, axilla, and groin, and are frequently of wide extent. Their removal may necessitate a very serious surgical procedure.



FIG 7—(Case 17) Lymphangioma of scrotum

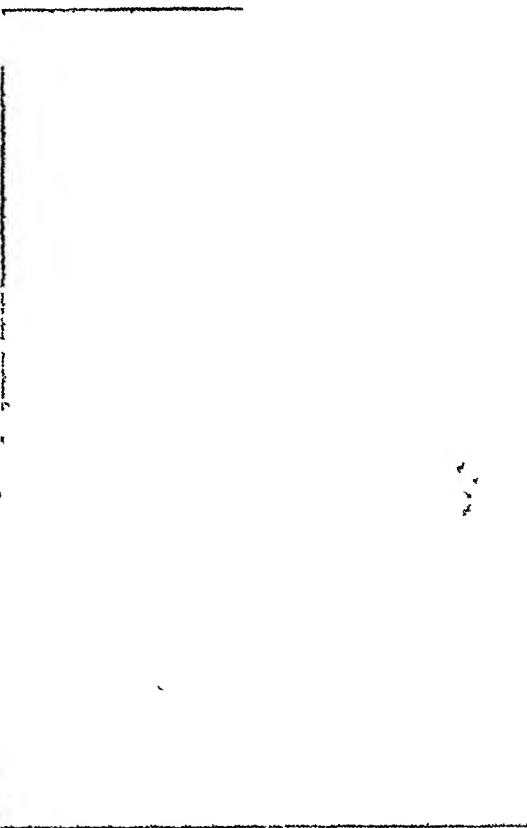


FIG 8—(Case 18) Large lymphangioma below inguinal ligament which at operation showed extension to the pelvis and retroperitoneally as high as the right renal vein

The *Cystic Lymphangiomata* are those tumors with larger thin-walled convoluted cysts filled with lymph and lymphatic fluid. These forms are not completely explained by developmental disturbances alone but almost so. The most typical ones are more often found in the neck, commonly spoken of as "Cystic Hygiomata." They are frequently present for a long time and then rapidly begin to enlarge. At other times after growing to a considerable size they seem to stop and rest. Keiller<sup>4</sup> says "There is every reason to suppose that these cystic hygiomata are at the outset cavernous lymphangiomata which become dilated with lymph, either as a result of a change in the drainage or an alteration in the function of their lining. The sudden onset and rapid growth may be explained by very active cell pro-

duction with an invasive power on the part of the endothelium and the extension of these tumors into the axilla and mediastinum has been thought to corroborate this view "



FIG 9—(Case 18) Photomicrograph showing a cavernous lymphangioma



FIG 10—(Case 20) Lymphangioma of right groin



FIG 11—(Case 20) Gross specimen showing hemorrhage into cavernous space

Therefore, wherever these centers exist congenitally, such tumors are possible, and wherever we find embryologic centers of great lymphatic pro-

duction, there we will find a greater number of such tumors, as for example in the neck, in the region of the jugular lymph sacs, subclavian, axillary, iliac and femoral, as well as mesenteric lymph sacs. If we consider these lymphangiomas as true blastomata, arising from undifferentiated mesenchyme, capable of producing lymphatic vessels by activity and growth of lymphangioblasts, in addition that there may be a blocking of outlets or possibly congenitally blind vessels, then we have sufficient cause for the responsibility of the development of these tumors. It is very probable that preformed lymphatics of normal function do not change and become in-



FIG 12—(Case 24) Cystic lymphangioma

involved in such tumor growths. Lymphangiomas, as mentioned before, are found in any part of the body, but more frequently in specific regions. Some of the most formidable, as well as interesting, are found within the abdomen, both retroperitoneally within the mesentery of the intestines, and some remarkable ones in the omentum. It is likely that few intra-abdominal cysts have any other origin than from lymphatics, if we exclude the large ovarian groups and occasionally one arising from the urogenital ridge.

Some of the outstanding reported cases are by McFadden,<sup>5</sup> Halsted<sup>6</sup> and Cohn.<sup>7</sup> Flynn<sup>8</sup> reports the removal of a large lymphatic mesenteric cyst in a young girl, 16 years of age, in which resection necessitated the removal of several feet of jejunum. Another interesting intra-abdominal

group are those found in the omentum. Guvin,<sup>9</sup> Outerbridge,<sup>10</sup> Funk,<sup>11</sup> Glausman and Jaffe<sup>12</sup> and Fisher,<sup>13</sup> all report interesting cases. Even as early as 1914, Outerbridge found 50 such cases in the literature. A very



FIG 13 — (Case 26) Cavernous lymphangioma of right cervical region



FIG 14 — (Case 26) Three years after operative removal



FIG 15 — (Case 27) Showing lymphangioma of right cervical region which at operation was found to extend into the floor of the mouth and into the mediastinum

illuminating article, with report of four cases of lymphangiomata of the neck, was written by Chas. N. Dowd,<sup>14</sup> in 1913. He first called attention to the relationship of the jugular lymphatic sacs of some of the vertebrate embryos with location and anatomic position of these cystic types of growth, establishing upon a firm basis the embryonic origin of these tumors.

The question of the cause of the various types of fluid which are found in lymphangiomata has been one which caused considerable controversy. It may be clear or exhibit various degrees of turbidity, particularly in the cavernous lymphangiomata. According to Keillei,<sup>15</sup> "This is almost certainly due to cellular contents. The fluid often contains enough albumin to coagulate spontaneously with many



cells and cell debris microscopically. In other conditions the fluid may be cloudy as a sequel to an old inflammatory process, or because of the formation of new lymphocytes. Lymph nodes are formed by the collection of lymphocytes within the lumen of the vessels and sometimes many lymphocytes are in their walls and between the lymph vessels and surrounding them. From the lymph nodes lymphocytes enter the cyst with stagnant lymph giving the milky fluid. At other times the fluid contains varying amounts of blood. This may be explained by supposing that when the lymphangioma is gradually growing and filling with lymph there may be a break down of the capillary walls with escape of blood into the sacs. At other times when

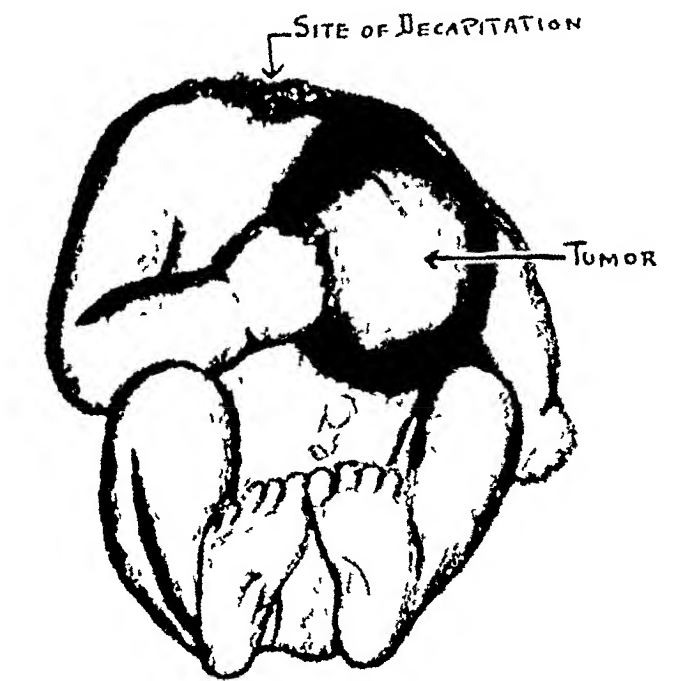


FIG. 16—(Case 12) Schematic drawing showing the large cystic lymphangioma in left axilla. Decapitation and puncture of the cyst was necessary before delivery could be effected.

the lymphatic vessels are small there may be a connection with the blood capillaries and lymphatic capillaries, and when the spaces are larger this communication may still be present." Both Halsted and Cohn report interesting lymphatic cysts with definite communication with large veins—the former reporting a retroperitoneal cyst communicating with the vena cava, while the latter reports an interesting lymphatic cyst of the neck definitely communicating with the jugular vein. In both of these cysts there was a large admixture of blood.

Answering a query from Doctor Halsted to Doctor Sabin in regard to this condition, the latter says "Recent work on the lymphatic system serves to demonstrate that lymphatic vessels occur first in the neck as sacs lined with endothelium and packed with blood, which lie close to the jugular vein. The abdominal lymphatics begin as sacs which are situated close to that part of the inferior vena cava which connects the two Wolffian bodies. Baetjer showed that in the pig, this sac, which is the forerunner of the retroperitoneal

lymphatics, communicates for a time with the inferior vena cava. These communications between the lymphatics and the abdominal veins, which are transitory in the pig, were shown to be permanent in the South American monkey by Silvester, while Job demonstrated similar connections in rodents. Thus the study of the development of the lymphatic system affords an explanation of anomalies involving connections between the lymphatic vessels and both the renal veins and the inferior vena cava.

*Prognosis*—There are few records of the final outcome of cases not treated. Within the abdomen in the mesenteric and omental cysts intestinal obstruction is a common complication (Flynn's case). In the tongue the

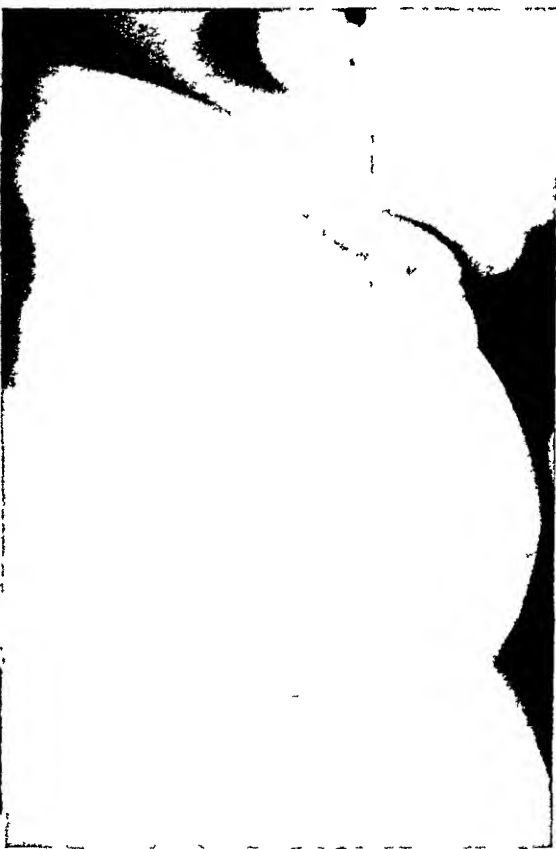
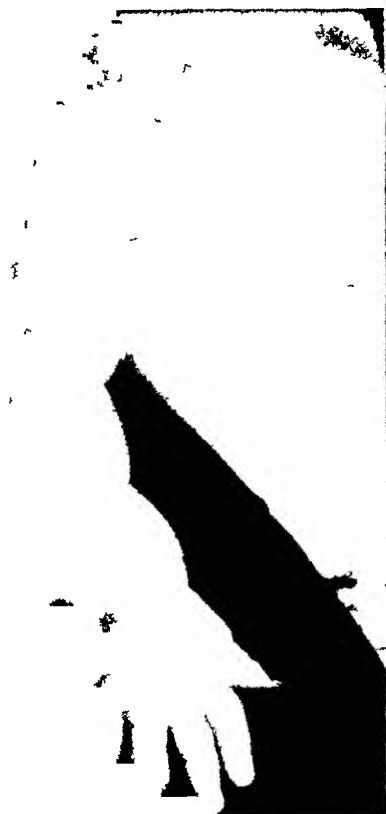


FIG 17—(Case 28) Cavernous and cystic lymphangioma involving the arm and hand

FIG 18—(Case 28) Following excision of cervical portion of extensive lymphangioma

enlargement may be so great that the mouth is overfilled resulting in exposure of the tongue with drying and ulceration (case 25). The most serious complication is that of infection. Because of the dysfunction of the lymphatic chain, infection is very serious due to the rapid spreading through the connecting cysts. Also, as there are communications between the cysts and venous radicles, blood stream infection may develop. Case 19, which we report with lymphangioma in the groin, after 30 years, became ulcerated, infected and died of septicemia.

*Treatment*—The treatment practiced in the past has varied. The injection of hot water into the cavernous type has been recommended by Redei.<sup>16</sup>

## LYMPHANGIOMATA

Excision is the most usual method of treatment. Some are quite easily managed but others are most difficult. The extent of the process may make their complete removal impossible (cases 18, 21 and 28). Several operations may be necessary, as recurrences are not uncommon.

The seriousness of their treatment may be appreciated when we see that of the 91 cases collected by Dowd, nearly all of which were operated upon, 38 died—a mortality of 42 per cent, the cause of death generally being infection, rarely secondary hemorrhage. Many of these cases occurred a number of years ago, when aseptic surgery was not so efficient as now, which probably resulted in a much higher mortality than exists today. Case 28 died of septicemia ten months following operation, and case 23 was septic and in a very serious condition for a long time. Two of the four cases



FIG 19 —(Case 28) Gross specimen of heart and mediastinum, showing large cavernous and cystic tumor of the mediastinum



FIG 20 —(Case 28) Photomicrograph showing infected cavernous lymphangioma

reported by Dowd died from sepsis following operation. At least, one should be mindful of the unusual danger of infection complicating operative procedures. The fact that infection is a much greater danger in these lymphatic systems, so far as I have observed, has not been referred to in the literature. Normal lymphatics have an important function in the presence of infection having the power of collecting microorganisms and filtering them out in the lymph nodes, while in lymphangiomata all lymphatic channels are not guarded by lymph nodes. Roentgen and radium therapy in certain types of lymphangiomata is highly recommended by the roentgenologist, and justly so in selected cases. In Case 25, lymphangioma of the tongue, improvement followed the use of radium. Where removal was incomplete because of wide extension within the retroperitoneal tissues and into the mediastinum, as in Case 27, which extended beneath the sternum, and which was incompletely removed, radiation apparently resulted in a cure.

TABLE I  
STATISTICAL RÉSUMÉ OF 28 CASES OF LYMPHANGIOMATA  
*From the Surgical Service of the John Sealy Hospital, Medical Branch of the University of Texas*

No	Hosp No	Age	Sex	Race	Age at Appearance	Location	Treatment	Pathology	Result and Follow Up
1	636	6	M	White	Birth	Back of neck	Excision	Simple	Recovery—no recurrence
2	8826	59	F	White	56	Nose—near inner canthus of eye	Excision	Simple	Recovery—no recurrence
3	2979	18	F	White	7	Tongue	Excision	Simple	Recovery and no recurrence after 2 yrs
4	17132	29	M	White	12	Upper lip	Excision	Simple	Recovery—no recurrence
5	10640	46	M	White	Childhood	Buttock	Excision	Simple	Recovery—no recurrence
6	SP2261	36	M	White	Childhood	Nose	Excision	Simple	Recovery—no recurrence
7	SP3831	—	M	White	Childhood	Tongue	Excision	Simple	Recovery—no follow up
8	SP5592	28	F	White	Childhood	Lower lip	Excision	Simple	Recovery—no recurrence
9	SP846	19	F	White	Childhood	Face	Excision	Simple	No recurrence
10	SP850	32	F	White	Childhood	Left index finger	Excision	Simple	No recurrence
11	SP7548	26	M	White	Childhood	Scalp	Excision	Simple	No recurrence
12	P2439	0	F	White	Birth	Large cystic tumor size of head in the left axilla	Excision	Cavern and cystic	The tumor was so large a decapitation and puncture of cystic tumor was necessary for delivery
13	7458	5	F	White	Birth	Swelling in right axilla	42 mg hrs of radium	Cavern	Recovery—no recurrence after 1 yr
14	22118	7	F	White	Infancy	Left shoulder	Excision	Cavern and cystic	Recovery—no recurrence after 9 yrs
15	45313	7 wks	M	White	Birth	Right lumbar region	Excision	Cavern	Recovery—well 5 mos later
16	17742	17	F	White	Birth	Left chest wall	Excision	Cavern	Recovery—no recurrence after 10 yrs

# LYMPHANGIOMATA

17	44970	38	M	Negro	28	Birth	Scrotum	Right groin with extension into pelvis and upward retroperitoneally to the right diaphragm	Excision	Abdominal portion removed as high as right renal vein through right rectum incision	Cavern	Recovery—well after 2 yrs
18	23703	18	M	White						Complete excision below inguinal ligament	Cavern	Recovery—no follow up longer than 1 yr Lymphatic drainage free from wound for several weeks
19	22032	49	M	White		Birth		Extensive tumor of right groin, lower abdomen and thigh	Radiation			
20	SM	3	F	White		Birth						
21	4000	1	M	White		Birth		Right groin and upper thigh	Excision			
22	28991	14	F	White		Birth		Anterior and posterior triangles of neck on left	One operation 12 days	Extensive dissection with partial removal	Cavern	Died of septicemia without operation
23	9300	8 mos	M	White		Birth		Left posterior triangle of neck, rather extensive	Three operative dissections			Recovery—well after 2 yrs *
24	2604	5	F	White		Birth		Extensive involvement of anterior and posterior triangles of neck on right	Extensive dissection with partial removal			Short course of roentgen therapy given 2 yrs later Patient well after 16 yrs with partial facial palsy †
								Anterior and posterior triangles of neck and right axilla	Excision by extensive dissection			Recovery—no recurrence 7 yrs after last operation *
												Recovery—5 yrs later had recurrence which was excised Died, age 13 yrs, of pneumonia †
												Recovery—no recurrence after 2 yrs

TABLE I (Continued)

No	Hosp No	Age	Sex	Race	Age at Appearance	Location	Treatment	Pathology	Result and Follow Up
25	27834	35	M	White	Birth	Lesion involved tongue, floor of mouth and right anterior triangle of neck	Excision of neck tumor followed by radium on tongue	Cavern and cystic	Tongue ulcerated Im-provement slow Ten yrs later with little inconvenience
26	45858	8	F	Negro	Birth	Right posterior triangle of neck	Excision	Cavern and cystic	Recovery—no recurrence after 3 yrs
27	49548	8	F	White	Birth	Anterior triangle of neck on right with extension into mediastinum and floor of mouth	Excision, partial, followed by 1,500 units of roentgen ray	Cavern and cystic	Recovery—no recurrence after 16 mos
28	40930	8 mos	M	White	Birth	Extensive lesion involving the anterior and posterior triangles of neck, mediastinum over clavicle superficial to pectoralis major, right shoulder, axilla and arm down to hand	Excision of cervical portion	Cavern and cystic	Ten months following the operation development of an infection in the tumor and baby died Autopsy revealed large mediastinal lymphangoma with infection throughout tumor

\* Cases of Drs W J and J L Jinks

Previously reported from this Department <sup>19</sup> (Cases 21 and 23) ANNALS OF SURGERY, 67, 385-396, April, 1923

**SUMMARY**—The embryologic development of the lymphatic system is discussed with an explanation of the origin of certain lymphatic tumors, which, though not truly congenital, may be considered as such. Twenty-eight cases are reported from the John Sealy Hospital, the teaching hospital of the University of Texas. The greatest danger from lymphatic tumors is infection, either with or without operation. Postoperative infection has caused many deaths. Complete removal is often impossible. Radiation is of value with or without surgery. Some are incurable.

**Note** I wish to acknowledge my indebtedness to Drs. T. G. Blocker, Jr., and J. F. Pilcher, from the Departments of Surgery and Pathology, Medical Branch, University of Texas, for their assistance in compiling the data necessary for the preparation of this paper.

### REFERENCES

- <sup>1</sup>Thompson, J. E. President's Address. *Surgery and Embryology*. Trans. So. Surg. Assn., 32, 14, 1919.
- <sup>2</sup>Keith, Sir Arthur. *Human Embryology and Morphology*. Wm. Wood & Co., 5th edit., 382, 1933.
- <sup>3</sup>Sabin, Florence R. *Lymphatics, Lymph and Tissue Fluid*. Drinker and Field, Williams & Wilkins Co., 2, 1933.
- <sup>4</sup>Keiller, Violet H. Personal communication.
- <sup>5</sup>McFadden, G. F. D. Retroperitoneal Cysts. *British J. of Surg.*, 18, 523, 1930-1931.
- <sup>6</sup>Halsted, W. S. Lymphatico-Venous Fistulae. *Trans. Amer. Surg. Assn.*, 37, 270, 1919.
- <sup>7</sup>Cohn, Isidore. Lymphatico-Venous Fistulae. Report of Case with Review of Literature. *Med. Rec. and Annals*, 30, 869, 1936.
- <sup>8</sup>Flynn, Chas. W. Mesenteric Cysts. *ANNALS OF SURGERY*, 91, 505, 1930.
- <sup>9</sup>Girvin, J. H., and Speese, G. Lymphangioma of Great Omentum. *ANNALS OF SURGERY*, 74, 792, 1921.
- <sup>10</sup>Outerbridge, G. W. Cystic Lymphangioma of Great Omentum. *ANNALS OF SURGERY*, 60, 680, 1914.
- <sup>11</sup>Funk, V. A. Cysts of Omentum. *Surg., Gynec. & Obstet.*, 18, 70, 1914.
- <sup>12</sup>Grausman, P. M., and Jaffe, H. L. Cystic Lymphangioma of the Greater Omentum. *ANNALS OF SURGERY*, 87, 66, 1928.
- <sup>13</sup>Fisher, W. H. Lymphangioma of Omentum. *ANNALS OF SURGERY*, 87, 872, 1928.
- <sup>14</sup>Dowd, Chas. N. Hygroma Cysticum Coli. *ANNALS OF SURGERY*, 58, 112, 1913.
- <sup>15</sup>Keiller, Violet H. Personal communication.
- <sup>16</sup>Reder, Francis. Result and Feasibility of Treating Lymphangioma with Injection of Boiling Water. *Surg., Gynec. and Obstet.*, 32, 70, 1921.
- <sup>17</sup>Lyle, H. H. M. Cystic Hygroma of the Neck. *EXCISION*. *ANNALS OF SURGERY*, 60, 398, 1914.
- <sup>18</sup>Lower, W. E. Haemangioma. *Surg., Gynec. and Obstet.*, 23, 591, 1916.
- <sup>19</sup>Thompson, J. E., and Keiller, V. H. Lymphangioma of the Neck. *ANNALS OF SURGERY*, 67, 385-396, April, 1923.

**DISCUSSION**—DR. ISIDORE COHN (New Orleans, La.)—The salient features of the patient upon whom I operated, and which Doctor Singleton referred to may be summarized as follows:

**Case Report**—Colored, female child, age two. Mother had noticed a lump in the right side of the neck soon after birth of the child. At no time had the child experienced pain nor had there been any inflammatory manifestations.

The mass, on examination, was found to be distinctly below the angle of the jaw, it was well circumscribed, and was not adherent to the skin. The floor of the mouth was smooth and was not encroached upon by the cervical mass, which could be transilluminated.

The preoperative diagnosis was branchial cyst. At operation we found a cystic mass which overlay the internal jugular vein, within which, lying on the posterior aspect of the sac, was a second circumscribed globular bluish mass. There were tributary veins which connected this mass from within the sac to the internal jugular vein. These tributary veins were fistulous connections between the lymph cyst and the jugular vein. The cyst wall was lined by endothelium.

I believe that the endothelial lining which we found and the venous fistulae are clinical evidence which supports the observations of Sabin, McClure and others, *ie*, that the lymphatics of the neck have their origin from the jugular sac. At least, the case presents two of the criteria of Sabin: (1) The connection between the jugular vein and the cyst, (2) the endothelial lining.

DR J GARLAND SIERRILL (Louisville, Ky) —It seems to me Doctor Singleton's paper has opened up a new field of investigation. I think we have all neglected this part of the anatomy and the diseases affecting it. The "why" of many of these things we do not understand. We see many tumors in the neck and the most dangerous of all types do not seem to grow for a long time and then begin to grow rapidly. Doctor Singleton has put this on a basis where we can study the "why" of these occurrences. We have always figured that the lymph always traveled along the main circuit, but we know that disease can travel backward from the proximal to the distal portion. We have a large field here and I hope the younger men will take advantage of it and clear it up much better than it has been done in the past.

DR JAMES BARRETT BROWN (St Louis, Mo) —I wish to ask Doctor Singleton if he has seen any congenital lymphangiomata in association with von Recklinghausen's disease.

DR ALBERT O SINGLETON (closing) —In answer to Doctor Brown's question regarding the etiology of lymphatic tissue in the tumors of von Recklinghausen's disease, I will say that this probably has a different etiology from the lymphangiomata under consideration, since it is secondary to the fibrous tissue formation in the primary neurofibromata which are the primary tumors in this disease and would be of the same character as elephantiasis secondary to the lymphatic obstruction, still the true lymphangiomata arise primarily from embryonic lymphatic centers.



# FIBRO-ANGIOMA OF THE SPLEEN

REPORT OF A CASE IN AN INFANT OF FOUR MONTHS

LON W GROVE, M D

ATLANTA, GA

As evidenced by the limited number of reported cases, primary tumors of the spleen are very rare, and fibro-angiomata are extremely rare. Krumbhaar<sup>1</sup> and Scott, in reporting a series of 28 cases of tumors of the spleen (1928), mentioned only one hemangioma. Matas<sup>2</sup> states that up until 1934 there had probably been 25 cases reported as splenic angiomata, but if these reports are carefully analyzed, several of them do not conform to his five histologic requirements descriptive of a true angioma, as in several cases there was evidence of metastases to other organs resulting in death of the patient. Matas<sup>3</sup> cites a case of true solitary cavernous angioma of the spleen in a man 53 years old, reported by von Beckendorff. The tumor was felt two years before it was removed. It was well defined and did not invade other tissues of the body. When we consider the histology of the spleen with its large vascular spaces and its delicate trabecular structure, it is surprising that it is not a more favorable organ for the development of angioma, but this is not the case unless we assume that a large percentage of nonparasitic cysts of the spleen are secondary to angioma of earlier life. In an analysis of the reported cases this does not appear to be true. Fowler<sup>4</sup> carefully analyzed 82 cases of cyst of the spleen and there were only two which he thought could possibly be secondary to an angioma.

It is difficult to differentiate histologically, or clinically, between true angioma, angiomatous cysts and angiosarcoma. The diagnosis is not made before operation and the true nature of the growth is determined by microscopic study.

Matas<sup>5</sup> states that cavernous angiomata of the spleen present a few characteristics that have been fairly well established since their histology was first studied by Billroth and Bohm, in 1899, and by Albrecht, in 1902, *ie*, "(1) In the spleen as in other organs the angiomatous spaces only displace and do not replace the missing parenchyma essential to the specific function of the organ, on the other hand the endothelial lining of the vascular lacunae apparently tends to increase the physiologic function of the normal splenic pulp. (2) The structure of the splenic angiomata does not differ essentially from that of cavernous angiomata elsewhere. (3) Splenic cavernomata are supplied and nourished by a vascular system intrinsically their own and to a large extent independent of the circulation of the organ itself. (4) The angiomata of the spleen like those of the liver do not invade or permeate the splenic tissue. They may remain small, stationary, well defined and symptomless during the life of the individual unless they become cystic, then they may

attain considerable proportions (5) They do not metastasize or spread to adjoining organs and their behavior is essentially that of benign neoplasms When appearing conjointly with similar lesions in other organs they are evidence of constitutional angiomata and usually are hereditary" In Dowd's<sup>6</sup> series, published in 1915, he described such a case reported by Ernst

Matas<sup>7</sup> believes that true angioma rarely metastasizes, while angiosarcoma frequently invades the liver, abdominal viscera, and even distant organs Dowd discussed the histogenesis of cavernous angioma of the spleen in connection with his case reported in 1915, and his conclusions were that in the published cases there was not sufficient proof to justify the diagnosis of sarcoma, and stated that the cases reported as angiomata must be so regarded He did not think they showed the characteristics of malignant tumors, but was unable to explain why these tumors at times take on unexpected and extensive growth

The first operation of splenectomy for angioma of the spleen was performed by Martin, of Paris, in 1909, and the patient recovered In the series reviewed by Dowd, including his case, six patients were operated upon, four recovered and two died The seven remaining cases were reported from autopsy records In six of the 13 cases the tumor was described as invading other organs, and if we are to assume with Matas that angiomata are benign and do not metastasize, six of the 13 reported cases were not true angiomata, but more probably sarcomata, showing secondary angiomatous change

**Case Report**—A K, female, age four months, was admitted to Henrietta Eggleston Memorial Hospital, November 15, 1935, exhibiting symptoms of sour stomach, vomiting and the presence of a lump in the left side of her abdomen The family history was negative except that her maternal grandmother, one uncle and three cousins had died of pulmonary tuberculosis The past history was negative She was a full term baby, her birth weight was 8½ pounds, she was breast fed, and in every way appeared normal until her present illness For one month previous to admission there had been noticed a slight icteric tinge to her skin She vomited after her feedings, was constipated, and restless

Physical examination revealed the child to be normally developed, well nourished, but pale She measured 24 inches in length and her weight was 12 pounds and 6 ounces There was no lymphadenopathy and no evidence of an acute infection In the left side of her abdomen, in the region of her left kidney, there was a firm, smooth mass which measured 8 by 5 cm It was freely movable, being easily displaced into either the right or left lower quadrant of the abdomen The upper and lower margins of the tumor were easily felt, as it did not extend beneath the costal margin There was no tenderness or rigidity of the abdomen, and the liver was not palpable

The urine was repeatedly negative except for a short while when there was one plus albumin and six to ten white blood cells A tuberculin reaction to 0.1 mg was obtained Old tuberculin was negative As shown in Table I, repeated blood studies were made and showed only a secondary anemia The platelet count and fragility tests were within normal limits Her temperature varied between 98.2° and 100° F A gastro-intestinal roentgenologic study revealed that the tumor was not connected with the digestive tract, a retrograde pyelogram proved that it was not connected with the genito-urinary tract and roentgenograms of the long bones were negative for metastasis

# FIBRO-ANGIOMA OF THE SPLEEN

TABLE I

## LABORATORY FINDINGS BEFORE SPLENECTOMY

	R B C	Hb	W B C	Neutro	Lymph	Other
Nov 15, 1935	3,140,000	70%	18,500	22%	76%	2%
Nov 21, 1935	3,190,000	62%	10,500	30%	67%	3%
Nov 23, 1935	Bleeding time 2½ min Coagulation time 3½ min					
Nov 25, 1935	3,330,000	61%	10,650	28%	68%	4%
Nov 25, 1935	Reticulocyte count, 4.6% Blood Wassermann, negative Blood Wassermann, negative					
Nov 25, 1936	Fragility test, hemolysis began at 46 and was complete in 36 Normal hemolysis began at 48 and was complete at 36					
Dec 3, 1935	3,160,000	55%	17,500	64%	35%	1

A laparotomy was performed December 3, 1935. The mass was found to be a tumor of the spleen which was removed. There was no evidence of similar growth in the liver, mesentery or omentum. The postoperative course was uneventful.

The spleen weighed 70½ Gm. The body was enlarged and rounded and in this area there was a semiresistant tumor mass. On cut section the tumor was grayish-pink in color with interspersing gray areas between areas of intervening red. The tumor measured 5 by 5 cm and was separated from the splenic tissue by a thin capsule.

Microscopic section showed the tumor to consist of proliferating fibroblastic cells which were laid down in a fairly dense compact manner. The fibroblasts varied in size and shape and grew in all directions. The blood vessels had in many areas only one or two red blood cells within them. The vessels were very numerous and there was an occasional large vascular space with a thin endothelial lining. The growth was separated from the splenic tissue proper by a capsule and the splenic tissue adjacent was flattened and atrophic.

The final diagnoses as reported by three pathologists were:

- (1) Fibro-angioma. No evidence of malignancy. Prognosis good. Dr. E. L. Bishop, Atlanta, Ga.
- (2) Fibro-angioma. Dr. Paul Cannon, Chicago, Ill.
- (3) Fibro-hemangioma. Dr. J. C. Norris, Atlanta, Ga.



FIG. 1.—Showing gross appearance of tumor in body of spleen.

TABLE II

## LABORATORY FINDINGS AFTER SPLENECTOMY

	R B C	Hb	W B C	Neturo	Lymph	Other	Platelets
Dec 4, 1935	3,200,000	54%	16,900	53%	56%	1%	190,000
Dec 5, 1935	3,820,000	53%	20,300	61%	38%	1%	200,000
Dec 6, 1935	2,980,000	54%	18,700	44%	53%	4%	210,000
Dec 7, 1935	3,460,000	55%	22,750	52%	48%		240,000
Dec 9, 1935	3,580,000	55%	15,700	46%	54%		300,000
Dec 11, 1935	3,650,000	60%	12,950	42%	56%	2%	340,000

TABLE II (*Continued*)

Dec 13, 1935	3,540,000	60%	25,500	40%	59%	1%	300,000
Dec 16, 1935	3,900,000	61%	26,150	38%	60%	2%	550,000
Dec 18, 1935	Bleeding time 3 min						
	Coagulation time 3 min						
Jan 3, 1936	3,870,000	66%	22,150	35%	73%	2%	420,000
Feb 25, 1936	4,900,000	68%	22,700	31%	69%		
Mar 17, 1936	4,260,000	80%	17,200				270,000
Nov 28, 1936	4,720,000		36,100				420,000
Nov 28, 1936	Bleeding time 2¾ min						
	Coagulation time 1¾ min						

As shown in Table II, repeated blood pictures were made during the first three months following splenectomy, and there was very little change noted in the blood picture. There was some increase in the leukocyte counts but not much more than is often seen following a splenectomy in the adult. When the blood was last examined, November 28, 1936, it showed a blood picture entirely compatible with good health. The baby had shown a normal growth for one of her age, and her weight was 21 pounds.

One might well ask the question, what will be the possible effect of splenectomy in a baby four months of age? I have found no other record of splenectomy in an infant that young.

The spleen is an organ that consists predominantly of two types of tissue, one of these being reticulo-endothelium and the other being lymphoid tissue. It is estimated that the spleen contains from one-third to one-half of the lymphoid tissue of the body and approximately one-fourth of the reticulo-endothelium. Therefore, it can be assumed that the removal of a normal spleen removes a portion of these two types of tissue. There still remains, however, an adequate amount of both types to carry on their function.

The spleen is not essential to life as has been well demonstrated following its surgical removal and in congenital absence of the organ, of which anomaly Riches,<sup>8</sup> in 1914, collected 13 instances from the literature. He concluded that these people showed no deviation from the normal and that the absence of their spleen in no way contributed to any type of ill health. It is not an unusual finding at autopsy to find spleens in adults who have died from some totally unrelated disease, that weigh only a few grams, and, practically speaking, could be considered nonfunctioning.

Wollstein and Kridel<sup>9</sup> performed splenectomy in 44 children, including three for traumatic rupture, 20 for rheumatic disease, one for splenomegaly, four for hemolytic icterus, eight for Cooley's anemia and eight for hemorrhagic thrombocytopenia. The ages ranged from 11 months to 12 years.

Probably the most valuable recent article on the effects of splenectomy is given in an abstract in the Journal of the American Medical Association, p 1138, March 28, 1936, in which Ash-Upmark collected 100 cases in which the normal spleen had been removed. Ninety-nine of these were traumatic. He followed these from one to 27 years after splenectomy. In addition he collected 94 cases from the literature. He found no increased susceptibility to infections or to malignant tumors. He noted a tendency to rapid exhaus-

# FIBRO-ANGIOMA OF THE SPLEEN

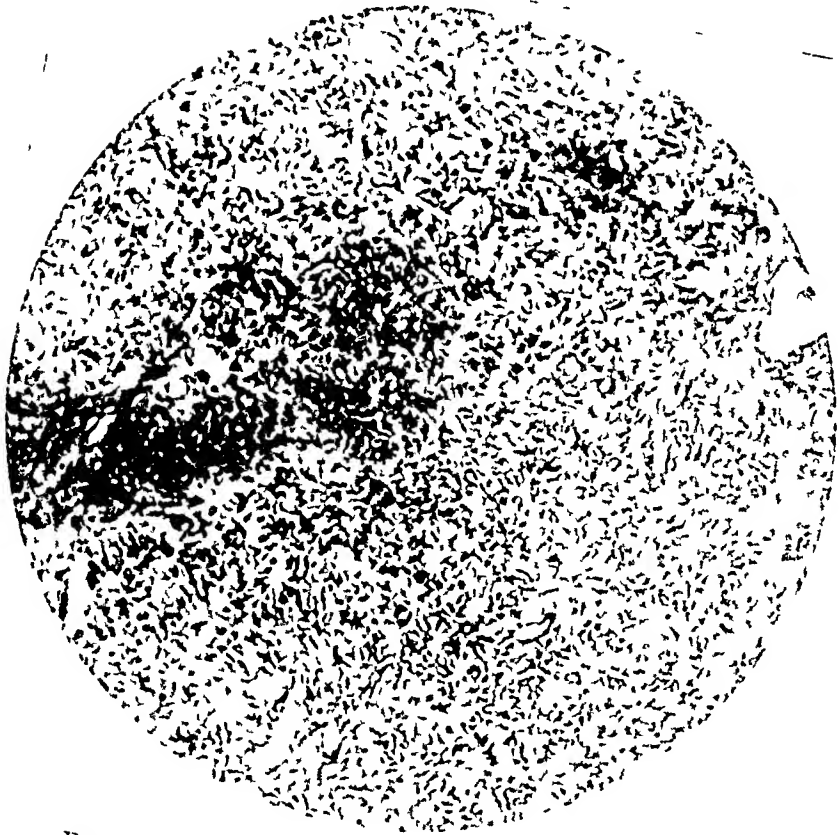


FIG 2 —Photomicrograph of tumor (low power)

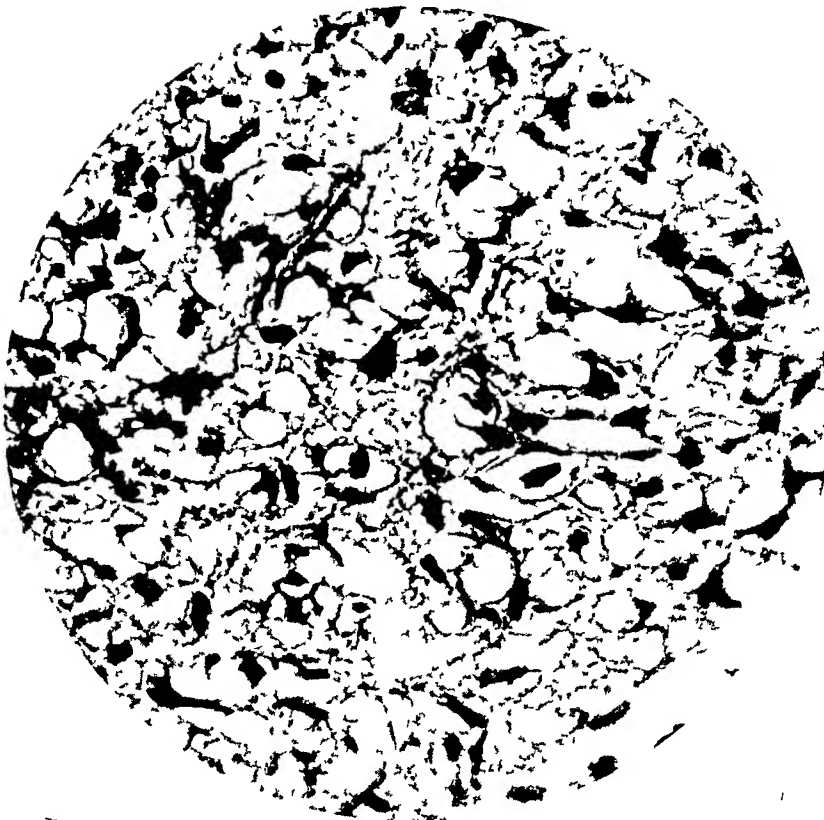


FIG 3 —Photomicrograph of tumor (high power)

tion, and states that people whose normal spleens have been removed should be accepted for insurance on the usual terms. He concludes that "Anatomically, physiologically and clinically, his investigations indicate that the spleen, while not necessary to life, should be removed only on vital indications."

Dominici<sup>10</sup> states that his results with splenectomy confirm the previous supposition that, in addition to the spleen, other sections of the endothelial system may also be responsible for excessive blood destruction, and that while splenectomy removes the principal seat of blood destruction, it does not remove all of the tissue having this function.

Kracke<sup>11</sup> believes that removal of the normal spleen is followed immediately by an increase in blood platelets, leukocytes and red cells. He believes further that during this postsplenectomy period the cells continue to be manufactured at their normal rate, but since part of the destructive mechanism is gone, they live to an older age in the blood stream. Therefore, it might be surmised that the average age of the cellular constituents is older than normal. This situation, however, soon corrects itself when the endothelial function is taken over by other tissues. Such compensatory hyperplasia would necessarily mean a slight generalized lymphadenopathy, which within itself would be of no importance. In the course of the lymphadenopathy, there would be excessive production of lymphocytes. Therefore, during this period, the patient may show a relative lymphocytosis.

## REFERENCES

- <sup>1</sup> Krumbhaar, E. B. Incidence and Nature of Splenic Neoplasm. *Ann Clin Med*, 5, 833-960, March, 1927.
- <sup>2</sup> Matas, Rudolph. Vascular Tumors. *Encyclopedia of Med*, 12, 834.
- <sup>3</sup> Matas, Rudolph. Vascular Tumors. *Encyclopedia of Med*, 12, 836.
- <sup>4</sup> Fowler, Royale Hamilton. Cysts of the Spleen. A Pathological and Surgical Study. *ANNALS OF SURGERY*, 2, 658-690, 1913.
- <sup>5</sup> Matas, Rudolph. Vascular Tumors. *Encyclopedia of Med*, 2, 835.
- <sup>6</sup> Dowd, D. M. Cavernous Angioma of the Spleen. *ANNALS OF SURGERY*, 2, 179-181, 1915.
- <sup>7</sup> Matas, Rudolph. Vascular Tumors. *Encyclopedia of Med*, 12, 837.
- <sup>8</sup> Riches, R. G. *Jour Ment Sci*, 60, 630, 1914.
- <sup>9</sup> Wollstein and Kridel. *Am Jour Diseases Child*, 51, 765, April, 1936.
- <sup>10</sup> Dominici, G. Clinical, Hematological, and Biological Recent and Late Effects after Splenectomy in Six Cases of Constitutional Hemolytic Icterus. *Hematologica*, 17, 185, 1936.
- <sup>11</sup> Kracke, Roy. Atlanta, Ga., Personal Communication, December 9, 1936.

# SUPPURATIVE ADENITIS OF THE ILIAC LYMPH NODES OF HEMOLYTIC STREPTOCOCCAL ORIGIN

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THERE have been very few reports published relative to retroperitoneal lymphadenitis during the past 15 years, and fewer still of intra-abdominal suppurative adenitis of hemolytic streptococcal origin. Although this type of infection has been recognized and studied in experimental animals, notably the guinea-pig, hemolytic *Streptococcus* has rarely been noted as a causal factor in intra-abdominal suppurative lesions in man. An epidemic in guinea-pigs of lymphadenitis with abscess formation due to this organism was reported by Hardenbergh,<sup>1</sup> in 1926. The health of the animals was not impaired to any extent, the disease being symptomless except for occurrence of the abscesses. "The mode and source of the infection was undetermined" in the animals studied. In 1929, Cunningham<sup>2</sup> cited an epizootic lymphadenitis in guinea-pigs due to a mucoid hemolytic *Streptococcus*, the disease being known as "lumps" and often characterized, in his experiments, by the formation of large retroperitoneal abscesses which had originated in the lymph nodes. As stated, the causal factors, or at least the source of infection, in these animals were not elucidated, yet it may be that some of these subjects are carriers just as certain individuals may be (Colebrook<sup>3</sup>). Undoubtedly in man carriers are responsible for certain cases of lymphadenitis of the intra-abdominal nodes. Colebrook found in a study of 181 normal individuals that 3 to 5 per cent showed the organism present in the nose and 5 to 10 per cent on the tonsils and walls of the nasopharynx. He thinks the hands may from time to time act as conveyors, in fact, of the 181 persons examined, 18 revealed *Streptococci* on the hands, in seven or 3.8 per cent of which the organism was of the hemolytic type. Five of the seven gave a history of "colds and catarrh."

In our review of the literature we have been able to find only six previously reported cases of suppurative intra-abdominal adenitis of hemolytic streptococcal origin. In Hyman's<sup>4</sup> review of 21 cases of retroperitoneal pelvic lymphadenitis observed at The Mt. Sinai Hospital, in the decade from 1920 to 1930, the hemolytic *Streptococcus* is not given as the bacterial factor. The infection in his cases occurred in the three gland groups, namely, mesenteric, lumbar and iliac, five of the 21 instances followed appendicitis, one a miscarriage, one diseased adnexa, two trauma and two infection in the lower extremities.

Primrose, in 1927, cites and discusses a case of hemolytic *Streptococcus* infection following operation for acute appendicitis in a young woman of seventeen. At operation there was also found a right pyosalpinx, the pus

from which later showed upon culture a growth of *Streptococcus hemolyticus*. The patient was treated by drainage and the intravenous injection of phenol, the latter having been shown by Maitland to increase the phagocytic action of the lymphocytes of the blood and probably also of the fixed tissue cells.

In the same year we find four additional cases published by Coutts.<sup>3</sup> In his series the iliac nodes alone were involved, the infection in all having its origin in the genito-urinary tract below the ureters, as one would expect if the lymph drainage of the urethra and bladder is recalled.

The above cases all made recoveries as did one observed by Topping,<sup>9</sup> in 1934. His case followed traumatization of the right elbow which caused a small contusion with a slight abrasion.

Recovery is not the rule in the cases with blood stream infection. Fortunately in the cases the surgeon observes the organism is arrested in the lymph nodes. These nodes belong to the hematopoietic system and in them are found lymphocytes and also monocytes. However, as the lymph flows from the afferent to the efferent lymph vessels bacteria are strained out and are here attacked by the phagocytes or macrophages formed from the fixed reticular cells of the nodes. These "energetically phagocytose varying foreign particles which come in contact with them" (Maximow). Even so, when one remembers that the abdominal lymph reaches the circulation not only by way of the thoracic and the right lymph duct but also directly by way of the venous capillaries of the follicle, thus passing directly into the blood stream (Maximow), it is difficult to understand why in such infections one does not see a general blood stream contamination. It is probable that in blood stream infections the organism may have been fed directly from the node into the circulation. In these as well as those confined to the lymphatic nodes the primary source may well be from the hands. Having shown the *Streptococcus hemolyticus pyogenes* to be present on the hands of 38 per cent of persons examined, Colebrook concludes that this accounts for the infections of fingers, open wounds and of the postpartum and post-abortion uterus, believing they are probably derived from the respiratory tract via the handkerchief. In our own case the atrium of infection was a raw surface present following the rupture of a vesicle in the condition commonly called "athlete's foot."

**Case Report**—G. W., male, age 24, noticed a ruptured vesicle on his left foot between the fourth and fifth toes. He painted this with mercurochrome and attended to his duties the following day. In the evening he had pain in the foot which soon extended to the lower leg and was accompanied by fever. He was examined by us the following afternoon at which time he had a temperature of 104°F, with swelling of the lymph nodes in Scarpa's triangle. The nodes were tender and much enlarged. He had had a chill. He was at once sent to the hospital from the record of which the additional data were obtained.

**Chief Complaint**—Left inguinal adenitis. Ulcerative lesion left fourth interdigital space.

**Present Illness**—Onset Friday, May 28, 1936. In the afternoon the patient noticed a small abrasion between the fourth and fifth toes. Also when looking downward over the inguinal region he noticed moderate swelling of the inguinal lymph nodes. He placed Whitfield's ointment over the abraded area. This did not produce any definite improve-



ment, so iodine was placed on the lesion, which caused more extensive ulceration. Also slight induration was present about the subcutaneous tissue under the fifth toe. The following morning the lymph nodes had become more enlarged and slightly tender. During the afternoon his temperature rose to  $104^{\circ}$  F, followed by a chill in spite of the application of ice packs over the inguinal region. The day of admission his temperature rose to  $104^{\circ}$  F, with three chills of such intensity as to shake the bed.

His family and past personal history were negative, as were the findings of his genitourinary, cardiorespiratory and nervous systems. There was some slight nausea.

*Physical Examination*—Temperature  $103^{\circ}$  F, respiration 20, pulse 120, blood pressure 120/80. He was well developed and well nourished. Skin. Slight abrasion between the fourth and fifth toes. Lesion is weeping. Only ulcerated connective tissue present between these two toes. No evidence of lymphangitis. Inguinal nodes in the left groin are markedly swollen, slightly indurated and tender. Eyes, ears, nose and throat were negative except for pupils of eye, which were dilated. (Incidentally this dilatation was present until the latter part of his illness.) Heart, lungs, abdomen and reflexes were normal. Agglutination tests for the *Bacillus of tularensis* were negative as were blood cultures.

The following day there was marked tenderness on deep pressure over the lower abdomen to the left of the umbilicus and internal to the pelvic brim. Two days later tenderness extended backwards toward the costal angle and the deep lymph nodes were palpable above Poupart's ligament. At this time there was no abnormal fulness observed. On account of the high, persistent fever, blood cultures were repeatedly made. Fragility tests were normal.

On the sixteenth day radiotherapy was begun (P K V 190. Filtration 0.5 Mm copper, 1.0 Mm aluminum. R U 420. Total 140 per dose. Erythema dosage 40 per cent). This was repeated on the eighteenth and twentieth days. This was followed by an apparent extension of induration toward the flank. On the thirtieth day of his illness, while the mass was smaller, there was definite point tenderness over the mass, and on July 1, he was operated upon.

*Operation*—A three inch incision was made about one inch above and parallel to the crest of the ileum, midway between the anterior and posterior superior spine. The fibers of the external oblique were split and the internal oblique muscle and transversalis cut across. The peritoneum was pushed forward and an abscess containing about two ounces of pus was opened. This abscess apparently began in the deep glands around the bifurcation of the common iliac vessel and the pulsation of the artery could be felt when the finger was inserted deep into the abscess. A very soft rubber tube was placed in the abscess cavity which was further packed loosely with gauze.

On July 9, it was determined to make a further exploration higher up and posteriorly. A three inch incision was made in the left kidney region through the muscles, and a finger inserted into the perirenal space. No pus obtained but the fat and all the tissues felt definitely infiltrated. The anterior wound was then explored and an abscess cavity was found to extend backward toward this incision. The wound was packed with dry gauze. Further exploration was not made because of the danger of opening the peritoneum posteriorly.

In the meantime repeated whole blood transfusions had been given and blood cultures repeated. On the tenth day following the second exploration 1 cc of aqueous metaphen was added to the blood given, and was followed by a decline in temperature and pulse. Three days later another 1 cc ampule of metaphen was given intravenously and his improvement became definite and continuous thereafter until his discharge from the hospital, 11 weeks after his admission. The pulse remained quite rapid following the least exertion for a month after discharge, but at present he is perfectly well.

*Critique*—During the course of the infection the following symptoms and physical signs were noted. Swelling and tenderness of and over the lymph nodes in Scarpa's triangle and later above Poupart's ligament. The tenderness was marked throughout and persisted until convalescence. As the disease progressed in the early stage this tenderness extended laterally into the flank and over the left renal region, which before the evacuation of the abscess was also quite painful to "hammer" percussion.

Before the suppuration was definitely located there was also some bulging in the ileocostal space, which was most noticeable in the lateral decubitus and over which fulness there was finger point tenderness. At no time was any evidence of the location of a suppurating node elicited by rectal examination. Once there was a slight yellowish discoloration of the conjunctiva but no rise in the icterus index.

Profuse sweating was present from the beginning as were also a marked and persistent insomnia and an appearance of anxiety. The sweating and insomnia persisted until the temperature began to decline. Nausea and vomiting at times were present and seemed to coincide with the occurrence of the chills which he had repeatedly even after the suppurating gland was evacuated.

Rigidity of the abdomen was present and was also persistent, as was abdominal distension and very active peristalsis.

The fall in red blood cell count, the pulse and temperature range are noted in the charts.

Roentgenograms were of no value in locating the area of arrest of the infection, and the curvature of the spine as pointed out by Lipsett<sup>7</sup> and by Beer<sup>1</sup> was at no time observed. There was, however, marked psoas spasm, especially upon full extension of the leg on the affected side, and the patient lay in bed with the left leg slightly flexed.

There was rapid decline in the red cells from the beginning and this persisted throughout, notwithstanding the repeated transfusions (Table I). Blood cultures were at all times negative though repeatedly made, and utilizing various media.

From the pus obtained from the abscess a gram-positive coccus was the only organism shown in the smear which was immediately made. Later from this same pus was grown a pure culture of *Streptococcus hemolyticus*.

**COMMENTS ON TREATMENT**—From the first we felt an almost irresistible urge to cut down on the nodes but were restrained by the uncertainty as to the exact location of the broken down node. Even after this node was opened and evacuated we were not sure that other nodes were not as badly involved.

Radiation treatment was given, possibly late, with the hope that the infection might clear up, or if not, that the breaking down process might be hastened. We might say here that we believe in roentgen therapy in acute infections, but that is a different thesis. At the second exploration of the flank, aside from extensive infiltration, nothing was found, and the tempera-



ture and the red blood cell diminution persisted. Both of these latter factors seem to have been markedly influenced by the administration of metaphen, particularly the temperature (Chart 1). Possibly Primrose's phenol may have had the same effect. Possibly the improvement in our case may have been a coincidence.

TABLE II  
RESUMÉ OF URANALYSES

	6/1/36	6/4/36	6/8/36	7/20/36	8/14/36
Appearance	Amber cloudy	Cloudy	Cloudy	Clear	Cloudy
Reaction	Acid	Acid	Acid	Acid	Alkaline
Specific gravity	1.007	1.007	1.015	1.020	1.022
Albumin	Faint trace	+	++	Heavy trace	Heavy trace
Sugar	0	0	0	0	0
Urobilin				Present	
Microscopic	Few bacteria renal epithelial cells	Numerous coarse granular casts many bacteria and occasional pus cast	Coarsely and finely granular casts many bacteria and occasional pus cast	Bacteria squamous epithelial casts	Few mucous threads uric acid crystals
Pus Cells per cm	Occasional	Occasional	Occasional	Occasional	10-12 per H.P.F.
Red Cells per cm	None found	None found	Occasional	90	None found

SUMMARY — We have reported a case of hemolytic streptococcal infection of the iliac lymph nodes, reviewing briefly the literature on such infections.

Repeated blood transfusions, roentgen therapy and evacuation of a localized suppurating lymph node apparently did not arrest the infection.

Marked improvement followed by rapid recovery seemed coincident with intravenous injection of metaphen.

#### REFERENCES

- <sup>1</sup> Beer, Edwin. Roentgenographic Evidence of Perinephritic Abscess. *JAMA*, 90, 1375.
- <sup>2</sup> Colebrook, L., Manted, W. R., and Johns, A. M. The Presence of Hemolytic and Other Streptococci on Human Skin. *Jour. Path. Bact.*, 41, 521, 1935.
- <sup>3</sup> Coutts, W. E. Acute Inflammation of Deep Iliac Lymph Nodes. *ANNALS OF SURGERY*, 86, 782, 1927.
- <sup>4</sup> Cunningham, John S. Epizootic Lymph-Adenitis in Guinea Pigs Due to an Encapsulated Mucoid Hemolytic Streptococcus. *Jour. of Infectious Diseases*, 45, 474, 1929.
- <sup>5</sup> Hardenbergh, John G. Epidemic Lymph-Adenitis with Formation of Abscess in Guinea Pigs Due to Infection with Hemolytic Streptococcus. *Jour. Lab. & Clin. Medicine*, 12, 119, 1926.
- <sup>6</sup> Hyman, Abraham. Retro-Peritoneal Pelvic Lymph-Adenitis. *ANNALS OF SURGERY*, 91, 718, 1930.
- <sup>7</sup> Lipsett, Philip J. Roentgen-ray Observations in Acute Perinephritic Abscess. *JAMA*, 90, 1374.
- <sup>8</sup> Primrose, Alexander. Abdominal Surgery in the Presence of Infection Caused by the Streptococcus Hemolyticus. *ANNALS OF SURGERY*, 86, 6, 1927.
- <sup>9</sup> Topping, M. H., Lepper, L. E., and Ward, E. T. Report of a Case of Streptococcus Hemolyticus Infection. *Med. Rec.*, 140, 121, 1934.

DISCUSSION —DR I. MIMS GAGE (New Orleans, La.) —Doctor Frank's paper interests me for we have had 25 or 30 cases of infection of the iliac group of lymph nodes. Most of our cases have been suppurative and most of them have been of the Streptococcus group, but not the hemolytic variety. About 5 per cent of cases will show the clinical manifestations of psoasitis, systemic manifestations of infection, and will subside without operation. We have had two cases which we thought were caused by the Streptococcus hemolyticus, but both recovered without operation. I think if one can establish infection of iliac group of nodes, it is better to wait until suppuration manifests itself before drainage is instituted. If you do not wait you are courting disaster. Recently a man of about 45 came in with a picture of suppurating iliac nodes on the right, from which we obtained about one quart of pus by incising above Poupart's ligament on the right. This healed without difficulty, but about three weeks later the patient returned with the same condition on the left side — a bilateral psoasitis. He still has a suppurating sinus on the left.

The clinical manifestations of iliac adenitis are flexion of the thigh on the abdomen, pain on extension of the thigh, and systemic manifestations of infection. If the infection is due to the Staphylococcus, the suppuration is not as severe and sometimes the abscess points below Poupart's ligament, simulating a tuberculous abscess. Incision and drainage in the fluctuating type will result in cure. In the acute type the patient usually will succumb

# THE STUDY OF WOUND HEALING

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PERHAPS an apology is due the members of the Southern Surgical Association for bringing to their attention the general subject of the study of wound healing. There was a time in the history of our profession when this subject commanded the major attention of surgeons. If they were then right in stressing the importance of the subject, certainly the vast increase in the incidence of both surgical and traumatic wounds has not lessened that importance, even though I fear that a large percentage of doctors and students of medicine have been encouraged to adopt the dangerous policy of taking for granted that the problem of wound healing has been solved.

In this audience there can be no question that the advancement and extension of modern surgery have been due more to the results of the prior studies of wound healing than to the birth of new ideas. And I, for one, am confident that a reemphasis of the principles of wound healing which were established long ago, as well as the renewal of investigative interest, especially along the lines of Curtis and others, will materially aid in improving the results of surgery as well as extending its field.

I realize that what I shall say today will neither be new nor helpful to you, but my excuse is that all the members of this association have a more or less definite responsibility for the molding and training of the lives of many who are to succeed us. With this in mind I have assumed that our viewpoint of the problem, and our efforts to teach the students and members of our graduate school of surgery the fundamental principles of wound healing and make them understand and apply them intelligently, may be of some interest to you.

In telling you of our plans, I want first to acknowledge a debt of everlasting gratitude to Dr. Wm. S. Halsted who, more than any man I ever knew, tried at all times to evaluate and apply the various principles of wound healing in his work. This was especially true in the laboratory where every study or experiment, regardless of its purpose, was, invariably, also made a problem of wound healing. For him an experiment was an unusual opportunity to observe the effects of different types of ligatures and sutures, variations of operative technic, the effects of necrosis, tight sutures, contamination, *etc.* Although the primary study was upon blood vessels, it was my duty to record most carefully the way in which the wound was handled, the character of the healing and, at subsequent operations and autopsies, to study microscopically and grossly the site of the wound. What I did not realize at the time was that he was teaching me by actual observation the significance of the various accepted principles of wound healing and was hoping that I would evaluate them and apply them to the best advantage of human beings in the hospital. With the greatest appreciation of what his time and patience

have meant to me, it has naturally become a duty in our clinic to endeavor to perpetuate his teachings, to instill the idea, so well expressed by Billroth, that "The proper treatment of wounds is to be regarded as the most important requirement for the surgeon."

For more than half a century we have been told that anesthesia, the control of hemorrhage and the control of infection have been responsible for the memorable progress of surgery. Yet we are well aware that in the life of a surgeon infection's primary rôle is a complication of the natural processes of wound healing. Even though this complication may at times be serious, tragic or even fatal, yet the fundamental processes of wound healing remain the same whether a wound heals by first, second, third or any other intention. Believing that it is erroneous to give students and young doctors the idea that the problem of wound healing is essentially synonymous with the principles of asepsis and antisepsis, we have deliberately fostered the idea that modern surgery owes its very life to anesthesia, the control of hemorrhage and to a better knowledge of wound healing. In this way the mind of the student is prepared for a consideration of all the fundamental principles involved in the problem rather than being encouraged to concentrate his whole attention on the aspect of bacterial contamination and sepsis. The development of clinical infection in a wound is by no means a matter of the presence of bacterial organisms, it is intimately related to other considerations which are also of basic importance, if one would understand the whole problem of wound healing.

Throughout the history of man's endeavor to aid wound healing, emphasis has at one time or another been placed upon various factors which are now recognized, theoretically, to be of fundamental importance. I say theoretically advisedly because it is my belief that, by and large, the doctor of this country is so dominated by the prevalent idea of asepsis and antisepsis that he is often sacrificing, to the detriment of the patient, other fundamental principles of wound healing. It is well for the student always to bear in mind that overzealousness in the utilization of any one principle of wound healing may often run counter to the application of other very valuable aids.

Among the first of the great principles of wound healing to become established was the importance of eliminating or preventing the formation of necrosis and debris in wounds. In the light of our present knowledge concerning the significance of bacteria in the healing of wounds, it has become necessary to establish in the minds of young doctors certain corollaries to this important contribution of Paré. He certainly proved that healthy living tissues have a remarkable power to ignore bacterial contamination and to combat clinical infection, even though he knew nothing about germs. Or, he proved that necrosis and debris in fresh wounds markedly handicapped their ability to handle the inevitable presence of microorganisms. And since Paré's time, it has been amply proved that necrotic tissue and foreign bodies were a definite handicap to the healing of a fresh wound even though it did not exhibit the generally accepted evidences of infection.

It is not enough to tell and show on human beings the truth of this principle of wound healing. The truth of the various principles of wound healing cannot well be driven home in the case of human beings, for the surgeon is neither willing, nor is it fair to the patient, to vary their application for purposes of teaching. And obviously it is impossible to reexamine and study the effects of any variation on human beings. Consequently, our students of surgery are naturally led into the acceptance and practice of the principles of their preceptors as a matter of mechanics secondary to surgical diagnosis and judgment. When the preceptor's basic ideas and practices are sound, then his pupil's may be as good, when they are bad, they will be perpetuated in his successors. Only when the student studies and understands the significance of the more fundamental principles of wound healing will he then be in a position to develop a technic of surgery commensurate with his abilities. In this paramount problem of surgery it is a crime to expect any student simply to perpetuate, without adequate understanding what he has seen and helped to do.

Fortunately, traumatic, ulcerated and infected wounds, extreme fluctuations of temperatures, and laboratory experiments afford excellent opportunities for demonstrating to oneself and one's assistants the truth of the various influences upon the healing of wounds. If you make two similar so called aseptic wounds upon an animal and in one, cause a great deal of traumatism, use many ligatures and tie sutures tightly, both of the wounds may heal without apparent infection. But if those two wounds are again inspected after a week there will be a vast difference in appearance. The one with excessive traumatism and strangulating ligatures and sutures will show much white necrotic tissue (in effect, foreign bodies) while the other may show a uniform healthy granulating surface. There will be no question about which one is the better place for bacteria to grow. If many such wounds are made and with equal bacterial contamination, there is no doubt about which one will show the greatest incidence of clinical infection and suppuration. Or, to use another illustration, one can repeat the classic experiments of Halsted and others of producing peritonitis in dogs. The healthy peritoneum can withstand and overcome enormous charges of saline suspensions of bacteria, while if a piece of potato, devitalized muscle or strangulated omentum be added to the cavity, relatively small doses of bacteria will result in peritonitis.

A few visual examples of this nature afford striking demonstrations of the rôle of necrosis in wound healing and will open up for the intelligent apprentice an unlimited field of application in the practice of surgery. Above all, they will teach him that living tissues deprived of their blood supply by trauma, tight ligatures, and sutures will die even though at the completion of an operation no apparent changes can be detected in their appearance.

It is easy to observe upon human beings the value of the principle of rest in wound healing, as was formerly so convincingly done by Baron Larrey,



Billroth and many others, and more recently emphasized by Ott and Koch. If one will make identical deep muscular wounds upon the extremities of two dogs and treat one dog by making him do daily walking exercise on a treadmill and the other by means of a plaster encasement, which puts the extremity at rest, there will be a striking difference in the wound healing even if there is no clinical infection. A reopening of these two wounds after one week affords an excellent illustration of the effect of trauma in the wound of the exercised dog and of rest in the wound of the immobilized extremity. Similar clinical differences in the healing of traumatic wounds as well as operative wounds of the extremities can be noted, even though the wounds are not reopened for inspection. Billroth noted this beneficial effect of rest and commented upon it as follows: "Of late I rarely see contused wounds do so well as compound fractures of the extremities, where plaster dressings are at once applied, hence we have a strong hint to compel absolute rest of an extremity with a large contused wound without fracture, by applying a fenestrated plaster splint. The cases where I have done this did remarkably well." We not only know that the immobilization lessens the reaction of wound healing, but that it also reduces materially the incidence of clinical infection. The simple conclusion is that wounds not subjected to the traumatization of activity are much more able to withstand the insults of bacterial contamination. The importance of this principle of rest should be thoroughly illustrated to, and completely understood by, every student of medicine. And it is not a difficult problem to demonstrate its effects both clinically and experimentally.

*Blood Supply*—The effect of blood supply is so easily demonstrated clinically that it is not necessary to resort to animal experimentation. All that is required is to note the differences in the healing of wounds of the lower and upper extremities, and of wounds in the young and old people. Anyone who has tried to aid the healing of an ulcer in a case of peripheral vascular disease knows the importance of trying to secure for it the best blood supply. A teacher who permits his students to believe that a case of leg ulcer, when admitted to the hospital, heals because of the local applications to the wound is neglecting his duty if he does not stress the value of an improved blood supply brought about by taking the patient off his feet.

Once a medical student or apprentice surgeon really understands what blood supply means to the growth of tissue in wounds, as well as its effect upon the control of infection, there will then occur to him countless ways in which he may use this principle to aid in the healing of wounds. It is our duty to see that he does not fail to understand it.

*Granulation Tissue* is an inevitable concomitant of wound healing, and as such, long excited the interest and study of surgeons before there was any knowledge of bacteria. A knowledge of bacteria, and an interest in aseptic and antiseptic procedures, have not eliminated from the process of wound healing the rôle of granulation tissue. Its part in the process remains just

as important today as it did centuries ago Do doctors and students understand that part today?

In the absence of the normal coverings and linings of the body, granulation tissue is the body's best defense against the invasion of bacteria or toxic substances To drive home this point let the student repeat Billroth's clinical experiment which was reported as follows "If you inject a drachm of putrid fluid into the subcutaneous cellular tissue of a dog the result will be inflammation, fever and septicemia If you make a large granulating surface on a dog and dress it daily with charpin soaked in putrid fluid it will have no decided effect On the border of the inflammatory new formation the lymphatic vessels are closed, on the granulating surface there are no open lymphatic vessels, hence no reabsorption takes place" Or he can make granulation tissue bleed and then note the inflammatory reaction after a dressing laden with bacteria He can make a fresh wound by the side of a granulating wound and then dress the two with identical putrid substances and note the differences in the inflamed reaction

If after these experiments a student begins to understand the protective and healing value of granulation tissue, he will perhaps think twice before he curescutes or cuts it away, before he makes it bleed or before he permits muscular action to damage it He may perhaps smile or know that he is being ironical when he speaks of unhealthy granulation tissue

The principal of hemostasis in wound healing may really be considered as a subdivision of Pare's teaching concerning necrosis and debris Blood, or blood clot, in a wound is in effect a foreign body, in addition to being doubly attractive food for bacteria There is usually ample opportunity to demonstrate on human beings the harm to wound healing of a blood clot and also its encouragement to the development of clinical infection This is easy to demonstrate on experimental animals

Unfortunately strict adherence to the principle of hemostasis, by means of ligatures and cauterization, also involves a sacrifice of Pare's fundamental idea of the value of eliminating necrosis The overzealous exponent of hemostasis may do a great deal of harm to wound healing by excessive ligation and cauterization, or the enthusiastic disciple of Paré may jeopardize wound healing by allowing hemorrhage and the formation of hematomata The attempt to control bleeding by pressure may cause necrosis or interference with blood supply The ideal of hemostasis which, at the present time, can be approached only from the standpoint of judgment and experience is the ligation (or cauterization) of only those bleeding points which require it, and the carrying out of this procedure in such manner as to do the least amount of tissue damage

There is no question about the value of the principles of asepsis and antisepsis to wound healing They are based upon the proved harm which bacteria may be to wound healing The trouble in this country today is not due to a lack of appreciation of this fact but to the execution of aseptic and antiseptic measures in such a way as to do more harm than good by ignoring

some of the other principles of wound healing and by a failure to appreciate what living tissues themselves can do to combat the presence of bacteria. All too frequently the price of aseptic and antiseptic solutions or procedures far outweighs the harm which may have resulted from the bacteria.

It is well to let every student prove for himself the harm of one or more of the countless germicidal agents which have been advocated for use in open fresh wounds. Let him make identical wounds upon a dog, wash one with salt solution and into the other pour iodine, or bichloride of mercury or alcohol or ether, and then dress them with simple Vaseline thereafter. The inflammatory reaction will be greater and there will be more sloughing in the wound treated with the antiseptics. Besides, daily bacterial counts will show that it harbors more bacteria. Similar experiments may be carried out with skin and granulation tissue in order to teach the student what he may be doing to living tissue when he uses any substance in an attempt to kill living bacteria in or on those tissues. In this way the student will get an idea of the tolerance of the skin and granulation tissue for the various kinds and strengths of antiseptics and of the intolerance of open fresh wounds to all of them. With this fundamental background fewer students will go out into practice to use, unintelligently, all kinds of antiseptics in the treatment of wounds.

In connection with this latter point, it would be wrong to give you the impression that we believe the use of every form of antiseptic therapy is harmful, it is not wrong, however, if I convey to you our belief that the use of every antiseptic should be questioned and its possible harm to living cells should be weighed against its value in the control of infection. We admit, as does most everybody, the value of the use of antiseptics upon the skin, we decry, as I believe everybody should, their use in lieu of careful scrubbing with soap and water or their application in such strengths as to cause blistering or excoriation. Next to epithelium in point of protection, and resistance to outside insults, comes granulation tissue, upon which *only when indicated*, do we believe the mildest antiseptics may be used to advantage, and then only when their application is possible without traumatization or causing bleeding. Upon fresh wounds we believe that all known forms of antiseptic drugs or cauterizations do more harm than good. For several years it has been our custom to wash them with normal salt solution both before and after débridement and to scrub them with soap and water when necessary to remove ground-in dirt or grease. In our minds there is no question but that the wounds so treated have healed more benignly and that the incidence of clinical infection has been far less frequent. It is clear to us that inasmuch as fresh wounds cannot be made absolutely sterile, the addition of any necrosis from the use of antiseptics is a definite hindrance to wound healing.

In a very large measure, if we will adopt the principle that every wound is a problem of tissue growth, it is my belief that there will soon develop among surgeons a better understanding and appreciation of the various factors concerned in wound healing. There would be no lessening of our efforts

to reduce to a minimum the incidence of bacterial contamination, for we would know that they can destroy tissue and especially eat up the medium in which the living cells must grow. If we preached that healthy living cells have a remarkable power to kill germs, and that dead cells are helpless against their invasion, then every effort would be made to eliminate from wounds dead and devitalized tissue. We would be zealous to adapt to modern surgery the fundamental concept of Paie, especially if we thoroughly understood and taught that in every wound of every kind there are always some bacteria regardless of our effort to avoid them.

Adherence to this principle of Paie involves not only a practical effort to eliminate from wounds all visible gross necrosis but also the elimination of the use of all germicidal substances which can kill countless invisible living cells, which by their presence retard wound healing as well as encourage the growth of bacteria.

If we taught that surface traumatism as well as the buried trauma of muscular action may kill the delicate living cells of granulation tissue and also open up avenues for the spread of infection and the absorption of toxins, there would result a greater endeavor to utilize intelligently Lally's fundamental principle of rest in the healing of wounds.

If every surgeon realized that for the growth and multiplication of living cells there must be food, every effort would be made to improve and preserve the food supply. Since in the final analysis the food comes from the blood, there would be a conscious endeavor to improve the supply of blood to every wound. Efforts along this line should not be confined to securing the best circulation to a part. As we learn more about the needs of growing cells, this may require the addition of various salts and substances which may be lacking in the patient's blood. Already we know something of the value of maintaining a normal fluid balance, of the addition of glucose, salt solution and blood to the patient's blood stream. The surface has only been scratched, in this line there is still a fascinating field for investigation. Locally, too, the preservation in the granulating wound of the food or medium which has been deposited from the blood and cells is of importance. When it is not being destroyed by bacteria, the surgeon's main concern is to preserve it in the best way possible. This is mainly a matter of local noninterference and the use of dressings which will not steal it away or destroy it. When, however, the bacteria are wholly, or in a large measure, devouring it, then it becomes advisable to use such measures as will inhibit or destroy the bacteria on the granulating surface and at the same time do the least damage to the living cells which are waiting to propagate themselves. Unfortunately, most of the measures used for this purpose are also damaging to the food or medium which the cells must have for growth. Thus their use, as well as the discontinuance of their use, must be a matter of judgment based upon observation, experience and clinical teaching, as well as the support to be obtained from laboratory studies.

It is also well to bear in mind that cells have an optimum temperature for

then growth. So far as we know, this is the normal body temperature. Consideration of this influence is of particular concern in the case of surface wounds, when it is easy to observe a diminution of the rate of healing of a wound in cold weather unless efforts are made to provide a relatively normal body temperature over the surface of the wound.

#### CONCLUSIONS

Wound healing remains today as important as it has ever been in the history of surgery. An understanding of the processes involved is absolutely essential to the intelligent practice of surgery.

It is our duty to teach the fundamental principles of wound healing, and to put an end to the prevalent practice of permitting a student's conception of wound healing to be the result of routines of practice in busy in- and outpatient surgical clinics.

The trend of our attitude toward this problem in the past generation and a half is convincing proof that doctors, and especially surgeons, should have more knowledge of the actual processes involved in the healing of wounds. There is no justification for permitting the development of the prevalent idea that wound healing is solely a problem of asepsis and antisepsis. Bacteria are only one of several complications in the process of wound healing.

# IS ADEQUATE MASKING ESSENTIAL FOR THE PATIENT'S PROTECTION?

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WITH the exception of the American farmer, there is no greater individualist than the American surgeon. It would be a waste of time for any authority, as at present constituted, to tell him that he could not operate unless he was adequately masked and expect it to be carried out, but if he can be convinced that adequate masking will protect his patient from an avoidable source of infection, then there will be no difficulty in having adequate masking adopted as a universal practice.

In hospitals with a surgeon-in-chief at the head of all surgery, it is a simple matter, if the chief so orders it, to enforce adequate masking in that institution, but ordinarily each surgeon must decide for himself on the importance of masking.

A number of articles have been written on this subject, and several years ago in a paper on "The Importance of Adequate Masking During Operation" I attempted to arouse further interest in this link in the complicated chain of operating room technic, which is so often found to be defective. Inasmuch as there are many surgeons who still operate without adequate masking, I feel that another contribution on the same subject may possibly reach some of them.

Adequate masking means the protection of the operative wound, by means of impermeable masks, from organisms which may be projected into it from either the mouth or nose of the operator or any member of the operating team.

In my work in reconstructive surgery, primary healing is particularly essential, and for this reason I have been especially interested in eliminating every avoidable source of infection.

In all well organized operating rooms, masking in some form is an almost universal practice, but this masking varies from two or three layers of loosely woven gauze over the mouth, which is practically valueless, to complete adequate masking of both nose and mouth.

With a vigorous scrub up and soaking of the hands in the solutions selected, followed by the sterile gown and intact sterile rubber gloves, the outside of which are not touched by the bare hands while being put on, we can fairly well eliminate contamination from this source. With modern, frequently checked up sterilization of all instruments, sutures, solutions and dressings which come in contact with the wound, except where there is a definite break in the technic, infection from this source can also be practically eliminated. The disinfection of the skin with any of several methods is generally effective. This leaves, roughly, two avenues from which infection

may be feared. One, from the direct discharge of microorganisms from the noses and throats of the operative personnel, and the other from the microorganisms in the air.

In studies by Meleney, Walker and others, it has been shown that serious infections of clean operative wounds have been caused by hemolytic Streptococci which were projected from the unmasked nose of the operator or some member of the operating team, and the individual responsible, and the specific organisms from the individual causing the infection have been positively identified.

In some experiments several years ago made under ordinary operating conditions utilizing always the same team, we found that there were from five to 23 more colonies grown on Petri dishes of heart muscle-blood agar, exposed for 15 minutes, when the mouths alone were masked, than when both mouths and noses were covered.

In an investigation of the bacteria of the nasal mucosa, Neumann examined over 200 individuals, of whom 111 were regarded as normal. He found diphtheroids present in 98 to 100 per cent, Staphylococcus albus in 98 per cent, Staphylococcus aureus in 30 per cent, Staphylococcus citreus and B. coli each 12 per cent, Sarcinae and pigmented micrococci each 8 per cent, Friedlander's bacillus in 6 per cent, Micrococcus roseus, pneumococcus and B. lactis aerogenes each 4 per cent, B. ozaenae and B. mesentericus each 3 per cent, molds and yeasts each 2 per cent.

When there is infection of the nasal passages other microorganisms may also be present, such as Streptococcus, hemolytic strains of Streptococcus and Staphylococcus, influenza bacillus, etc. It can thus be seen that the nose is the habitat of bacteria of many varieties and of varying virulence.

Meleney has found that cultures from infected clean wounds show principally white and yellow Staphylococci. Streptococci, hemolytic Staphylococci and Streptococci are grown in a much smaller number of cases, and only occasionally can other types of virulent microorganisms be cultured.

Few operators or members of operating teams know whether they are hemolytic Streptococcus or Staphylococcus carriers or not, and no one in these groups knows when he may become infected, especially in the winter epidemic season. In an interesting investigation, Meleney found that 33 per cent of the operating personnel in a New York hospital, with no epidemic going on, harbored hemolytic Streptococci in the throat and many also carried it in the nose.

In two epidemics in Boston, Walker pointed out that the percentage of Streptococcus carriers in the operating room personnel, including the surgeons, was 50 and 58 per cent respectively. We have all seen infections occur in clean cases following which a check-up was made on everything in the way of operative technic, but no attention was paid to the fact that the operator was not adequately masked. In fact, in the majority of instances no one even dared to suggest that the operator might be the source of the infection. I am convinced that many serious infections, sometimes single

and sometimes in series, which have been blamed on lack of proper sterilization of catgut, or dressings or instruments, could be traced, if properly investigated, to the unmasked nose of the operator or some member of the team.

As an example, I recently heard of an instance where a number of serious Streptococcus infections occurred in clean cases operated upon by the same surgeon. Finally, it was discovered that the surgeon was an hemolytic Streptococcus carrier and was accustomed to operating without masking his nose. This is only one of many such happenings which have come to my attention.

Sometimes infections will occur in clean operative wounds even though the entire operating personnel is properly masked, and where, as far as can be found out, there has been no break in technic. In such cases, infections by air borne microorganisms must be considered. It has been found that orderlies, who are acutely infected or are natural carriers, and who frequently pass through, or clean, the operating rooms without being masked, may be the indirect source of the infection by the air route.

Dr. Irving Walker of Boston has long been interested in the study of adequate masking and in describing the ideal mask says: "The ideal surgical mask should be one that (a) under all conditions will absolutely prevent the passage of organisms through the material of the mask in the direction of the wound, or material concerned with the operation, when both the nose and the mouth are covered, (b) will be comfortable in all degrees of temperature and will not fog the glasses, (c) will be of low original cost, or of such construction that it can be used economically many times with sterilization following each use." A mask which fulfills all of the ideal requirements has not yet been devised, but nevertheless effective masks may be made of many materials, and many types are in use.

At the present time, I use in my own work two masks made of three or four thicknesses of a closely woven muslin having from 60 to 65 strands to the square inch. Over a cap which covers the hair one of these masks, which is sufficiently large to block out the mouth, is tied. Over this is placed a second mask which is large enough to completely cover the mouth, chin and nostrils, and this is held close to the bridge of the nose by a strip of aluminum inserted under a fairly broad piece of tape sewed across the center of the upper margin. Each mask is secured by four tapes. The layers of material do not become wet through from the breath during an ordinary operation and taken together are apparently impermeable to microorganisms. There is little if any trouble with fogging glasses, as the metal band holds the mask close to the nose, and with the use of one of the antifog preparations in addition, the glasses will remain clear.

The subject of adequate masking suggests a brief consideration of air borne bacteria, inasmuch as the bacteria projected from the mouth or nose of an inadequately masked individual in breathing, talking or coughing in the operating room, may either pass directly into a wound or subsequently may be carried into it while still suspended alive in the air or by air currents after dying.



The swing of the pendulum from the steam jet and wet technic, where every stress was laid on air borne microorganisms, to dry, and the tendency to ignore the air borne microorganisms as innocuous, has undoubtedly gone entirely too far. There is no question as to the possibility of air borne infection, and I am glad to say that much more attention is being paid to infections of clean cases caused by air borne pathogenic microorganisms.

It is well known that when an operating room has been left perfectly quiet without any one entering over a period of hours, that the dust particles in the air are less in number, and consequently the number of bacterial colonies on test plates are much fewer. On the other hand, the use of an electric fan in an operating room, which we frequently see during hot weather, stirs up every particle of dust which is in the room, and if infected material is present, which it usually is, undoubtedly serves as a most effective means of spreading it.

In Penfield's operating room in the Montreal Neurologic Institute, the air entering the room is washed with water and oil spray, but in addition in order to minimize any dust and air borne microorganisms which may still remain, the following routine is used. The operating room is cleaned in the afternoon and the floor is washed. The floor and top of the operating light, *etc*, are covered with 50 per cent glycerin in water, which is allowed to remain so as to catch and hold any dust that may settle overnight. No one is allowed to enter the room until next morning, when final preparations are made by the nurse, who is fully gowned and masked.

Gudin, who is greatly impressed with the importance of air borne infection, reports in the *Presse Médicale* for March 4, 1936, an elaborate method of true air sterilization and absolute protection of the patient from this source, in specially constructed operating rooms with filtered sterilized air, air locks, *etc*, into which only the operator, the assistant, and anesthetist are allowed to enter during the operating period. This system is apparently most effective in preventing air borne infection, but even with this set-up, unless adequate masking is practiced, the patient is still exposed to what may be the most virulent type of wound infection.

Deryl Hart has been using a method by which air borne bacteria in the operating room may be disposed of by a type of radiant energy generated in special tubes. In a personal communication, he says in regard to the radiant energy device which he uses: "It will kill a lightly sprayed culture of hemolytic *Staphylococcus aureus* at a distance of five feet in 60 seconds, or a heavily sprayed culture within less than five minutes at the same distance. It eliminates almost completely, within a radius of eight feet of the operating table, the shower of bacteria which can be caught on a Petri dish of blood agar at almost any time. Our postoperative results have been in keeping with what would be expected by the elimination of this rain of bacteria."

This is a very interesting and important contribution, and if prolonged exposure to this bactericidal radiant energy proves to be without harmful effect to the patient, to tissues of various kinds, or to the operating team, it

will probably be the least expensive and may be the most effective method yet devised of disposing of air borne bacteria. Even though this method may be proven 100 per cent efficient for disposing of the ordinary bacteria in the air and for hemolytic strains when exposed sufficiently long, nevertheless, adequate masking, which is required for the protection of the team from the rays, would be essential even if unnecessary for ray protection, as no rays, however effective, can destroy the vitality of microorganisms projected directly from the nose or mouth of the operator into the open wound quickly enough to prevent infection.

Eventually, it may be possible to destroy pathogenic bacteria in the noses and throats of all operating personnel by having them exposed to irradiated air of some sort, and this may in time be a valuable method of handling hemolytic *Streptococcus* or *Staphylococcus* carriers, but until this becomes an assured fact, adequate masking will still be essential.

COMMENT—As a precautionary measure, any member of an operating team with an acute respiratory infection should be kept out of the operating room. All who are known to be carriers of hemolytic strains of *Streptococcus* and *Staphylococcus* should be banished until they are cleared of the infection.

It is significant that many of the microorganisms which are usually found in the nasal passages grow on the room control plates of operating room air. An idea of the most common microorganisms from the air which we have grown on these plates can be gathered from the following list: *Staphylococcus*, *albus* and *aureus*, some *Streptococci*, diphtheroids, *Sarcinae*, *Micrococcus catarrhalis*, *B. subtilis*, *Proteus vulgaris*, molds, a few hemolytic *Streptococci* and *Staphylococci*, a very few colon bacilli.

We have noted that the longer the time of plate exposure the greater were the number of colonies grown. For instance, room control plates when the team was completely masked with a 15 minute exposure showed 29 colonies. Under similar conditions, in the operating field, during a two hour operation 71 colonies were grown. In both of these experiments only the operating personnel were present. On the other hand, in a two hour exposure of the room, control plates in two different operating rooms with observers on the floor, one showed 96 colonies and the other 93 colonies. The presence of so many microorganisms in the air of operating rooms in a modern hospital is certainly astounding.

It is well known that patients operated upon before a crowd of observers, who are on the floor and in the stands, frequently have a stormy convalescence as far as infection is concerned, and this fact should be borne in mind by those who contemplate giving an operative surgical clinic.

In certain hospitals the observers are not allowed in the operating room at all but are in a gallery or room entirely sealed off from the operating theater. By means of reflecting mirrors, or by direct vision, or by means of opera glasses, the steps in the operation can usually be much more plainly seen than when the observer stands beside the table. The explanation, as the work proceeds, is given by the operator through a microphone and us-

ually can be clearly heard. This is of course, the safest and most satisfactory method. In the majority of operating rooms, however, observers are allowed on the operating floor or in stands near the table. It is needless to say that every observer under these conditions should be as carefully masked and gowned as the operating team, but unless this rule is continuously insisted upon it can seldom be enforced, as few observers seem to realize the danger of their bringing infection into the operating room and thence through the air to the clean wound.

Proper masking should be carried out in all accident departments, at least by the operator and his assistants. This may seem far fetched in accident rooms where air borne microorganisms is notably so numerous, but with tissues in a bruised and nonresistant state following accident, they usually have all they can do to take care of air borne contamination and contamination which clean-up or débridement cannot thoroughly remove. When to this may be added, say, hemolytic *Streptococci* projected from the nose and throat of the operator while carrying out the repair, there is no doubt in my mind that serious infection from this source may and does occur. If infection develops, it is of course blamed on contamination from the accident, but may well be caused by microorganisms from the nose or throat of the operator himself.

Adequate masking is just as essential for the protection of the patient during operations in every one of the surgical specialties as it is in general surgery, but many specialists do not seem to realize this.

The patient whose face is not covered during anesthetization, either general or local, should be masked when in the operating room, as there is little doubt that an unmasked patient with hemolytic strains in nose or throat may be the source of infection to his own clean wound through the air. As a matter of fact, it would be safer for us all to use an impervious mask even when doing ordinary surgical dressings.

Many times during an operation, with the patient in the usual prone position, the operator's face is directly over the wound, seldom more than 18 inches away and frequently as close as 12 inches. When we realize that microorganisms are being constantly showered from the nose into the wound during ordinary respiration, it is appalling to see an operator and his first assistant with noses uncovered breathing into an open abdomen, or an exposed brain, or a wide open breast defect, or any other wound for, say, an hour or longer. Would any of you care to be exposed to this unnecessary risk if you were the patient?

Every wound under usual operating room conditions is contaminated during operation, but fortunately relatively few become infected. Knowing what we do about the microorganisms to which clean wounds are exposed, even when adequate masking is practiced, it is extraordinary that any of them ever escape infection. That they do escape is probably due to the effectiveness of the natural resistance of the tissues and also to the fact that different individuals undoubtedly vary in their susceptibility to infection.

In my own work, I feel that an appreciable amount of contamination is avoided by the frequent washing out of the operative wound with ether, and that this procedure is largely responsible for removing many of the pathogenic air borne bacteria, which are practically always present in the operating room, as well as washing out the pabulum upon which they thrive

Frequently, the so called filtered air of operating rooms, while somewhat less contaminated, is far from clear of dust and microorganisms. In the air conditioned operating rooms, there is little difference in the number of colonies which grow on the sterile Petri plates of blood agar. It is futile to filter and sterilize air going into an operating room when doors are constantly being opened, and attendants are passing in and out.

In some clinics, sterile boots made of some washable material are drawn over ordinary shoes or special operating shoes, and this is to be commended as it undoubtedly minimizes, to a certain degree, the amount of extraneous dust and the accompanying organisms brought in from the outside.

We all know that many operations are performed on clean cases without infection occurring, even though adequate masking is not carried out, so no one can make the statement that infection will always occur when noses and mouths are not covered. It can be stated however, without reservation, that in order to protect the patient from a source of infection, which is known to be due to inadequate masking, no surgeon is justified in exposing the wound to this avoidable hazard.

The postoperative results in those hospitals where adequate masking is a routine and where every effort is made to minimize the air borne bacteria are without question much better than where these precautions are not taken.

It is my belief that observers, cleaners, orderlies, nurses, anesthetists and doctors should be adequately masked both during the operation and whenever they come into the operating room. Every available method which has been proved of value in protecting clean cases from infection should be employed, but I am convinced that if all the accepted procedures are used in the way of clean-up and of sterilization of equipment, and of the air in the operating room by filtration or rays or any other method, it will still be essential for the operating personnel to cover their noses and mouths with impermeable masks. In short, I feel that adequate masking is not only essential but is the most important procedure, in addition to rubber gloves and gentle handling of tissues, that the surgeon can personally carry out to prevent infection in clean operative wounds.

#### REFERENCES

- <sup>1</sup>Beck, Wm C. Preparation of Operative Field. Report of a Survey of Seventeen Surgical Teaching Clinics. Arch Surg, 876, November, 1936.
- <sup>2</sup>Davis, J S. The Importance of Adequate Masking during Operation. ANNALS OF SURGERY, 1008, November, 1934.
- <sup>3</sup>Gudin, M. Asepsie fictive et sterilisation totale. La Presse Medicale, 355, March 4, 1936.
- <sup>4</sup>Hart, D. Sterilization of the Air in the Operative Region with Bactericidal Radiant

- Energy ANNALS OF SURGERY, 105, May, 1937 Sterilization of the Air in the Operating Room by Special Bactericidal Radiant Energy J Thoracic Surg, 6, 45-81, October, 1936
- <sup>6</sup> Meleney, F L Infection in Clean Operative Wounds Surg, Gynec and Obstet, 60, 264, February 15, 1935 Seasonal Incidence of Haemolytic Streptococcus in the Nose and Throat J A M A, 1392, April 30, 1927
- <sup>7</sup> Meleney, F L, and Stevens, F A Postoperative Haemolytic Streptococcus Wound Infections and Their Relation to Haemolytic Stieptococcus Carriers among the Operating Personnel Surg, Gynec and Obstet, 338, September, 1926
- <sup>8</sup> Neumann, R O Ztschr f Hyg u Infektionskrankh 40, 33-53, 1902
- <sup>9</sup> Penfield, W Personal communication
- <sup>9</sup> Walker, I J How Can We Determine the Efficiency of the Surgical Mask? Surg, Gynec and Obstet, 266, January, 1930 Discussion Surg, Gynec and Obstet, 276, February 15, 1935
- <sup>10</sup> Waters, E G Adequate Surgical Masking Problem and Solution Am Jour Surg, 474, June, 1936
- <sup>11</sup> Wells, F W, and Wells, W W Air-Borne Infection J A M A, 1698, November 21, 1936 Air-Borne Infection Sanitary Control J A M A, 1805, November 28, 1936

## THE PATHOGENESIS OF LOCAL TETANUS

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MEDICAL literature is rich in historic records of many of our most commonplace diseases which have held the interest of all branches of medicine for centuries. In many instances some of these diseases have defied human intelligence and medical research, and forced the profession to realize that the day is far distant when medical science will have conquered all diseases.

Today I wish to invite your attention to the discussion of a certain phase of one of the oldest diseases known to man—tetanus—for which much has been done in a preventive way but for which the present day method of treatment is practically the same as it was many centuries past.

As a preamble to this discussion, an article from the works of Aretaeus the Cappadocian, written in the third century A D, will serve to give you an idea of what was known of tetanus at that time and how bewildered those medical men were when called upon to treat a case of tetanus. In discussing this disease, Aretaeus (Group I<sup>15</sup>) wrote as follows:

“Tetanus, in all its varieties, is a spasm of an exceedingly painful nature, very swift to prove fatal, but neither easy to be removed. They are affections of the muscles and tendons about the jaws, but the illness is communicated to the whole frame, for all parts are affected sympathetically with the primary organs. There are three forms of the convulsions, namely in a straight line, backwards and forwards. Tetanus is in a direct line, when the person labouring under the distension is stretched out straight and inflexible. The contractions forwards and backwards have their appellation from the tension and the place, for that backwards we call *opisthotonos*, and that variety we call *emprosthotonos* in which the patient is bent forwards by the anterior nerves. For the Greek word *tonos* is applied both to a nerve and to signify tension.

“The causes of these complaints are many, for some are apt to supervene on the wound of a membrane, or of muscles, or of punctured nerves, when for the most part, the patients die, for, ‘spasm from a wound is fatal.’ And women also suffer from this spasm after abortion, and, in this case, they seldom recover. Others are attacked with the spasm owing to a severe blow in the neck. Severe cold also sometimes proves a cause, for this reason, winter of all the seasons most especially engenders these affections, next to it, spring and autumn, but least of all summer, unless when preceded by a wound, or when any strange diseases prevail epidemically. Women are more disposed to tetanus than men, because they are of a cold temperament, but they more readily recover, because they are of a humid. With respect to the different ages, children are frequently affected, but do not often die, because the affection is familiar and akin in them, striplings are less liable to suffer, but more readily die, adults least of all, whereas old men are most subject to the disease and most apt to die, the cause of this is the frigidity and dryness of old age, and the nature of the death. But if the cold be

along with humidity, these spasmodic diseases are more innocent and attended with less danger

"In all these varieties, then, to speak generally, there is a pain and tension of the tendons and spine, and of the muscles connected with the jaws and cheek, for they fasten the lower jaw to the upper, so that it could not easily be separated even with levers or a wedge. But if one, by forcibly separating the teeth, pour in some liquid the patients do not drink it but squirt it out, or retain it in the mouth, or it regurgitates by the nostrils, for the isthmus faucium is strongly compressed, and the tonsils being hard and tense, do not coalesce so as to propel that which is swallowed. The face is ruddy and of mixed colours, the eyes almost immovable, or are rolled about with difficulty, strong feeling of suffocation, respiration bad, distension of the arms and legs, subsultus of the muscles, the countenance variously distorted, the cheeks and lips tremulous, the jaw quivering, and the teeth rattling, and in certain rare cases even the ears are thus affected. I myself have beheld this and wondered! The urine is retained, so as to induce strong dysuria, or passes spontaneously from contraction of the bladder. These symptoms occur in each variety of the spasms.

"But there are peculiarities in each, in Tetanus there is tension in a straight line of the whole body, which is unbent and inflexible, the legs and arms are straight

"Opisthotonos bends the patient backward, like a bow, so that the reflected head is lodged between the shoulder blades, the throat protrudes, the jaw sometimes gapes, but in some rare cases it is fixed in the upper one, respiration stertorous, the belly and chest prominent, and in these there is usually incontinence of urine, the abdomen stretched, and resonant if tapped, the arms strongly bent back in a state of extension, the legs and thighs are bent together, for the legs are bent in the opposite direction to the arms

"But if they are bent forwards, they are protuberant at the back, the loins being extruded in a line with the back, the whole of the spine being straight, the vertex prone, the head inclining towards the chest, the lower jaw fixed upon the breast bone, the hands clasped together, the lower extremities extended, pains intense, the voice altogether dolorous, they groan, making deep moaning. Should the mischief then seize the chest and the respiratory organs, it readily frees the patient from life, a blessing this, to himself, as being a deliverance from pains, distortion, and deformity, and a contingency less than usual to be lamented by the spectators, were he a son or a father. But should the powers of life still stand out, the respiration, although bad, being still prolonged, the patient is not only bent up into an arch, but rolled together like a ball, so that the head rests upon the knees, while the legs and back are bent forwards, so as to convey the impression of the articulation of the knee being dislocated backwards

"An inhuman calamity! an unseemly sight! a spectacle painful even to the beholder! an incurable malady! owing to the distortion, not to be recognized by the dearest friends, and hence the prayer of the spectators, which formerly would have been reckoned not pious, now becomes good, that the patient may depart from life, as being a deliverance from the pains and unseemly evils attendant on it. But neither can the physician, though present and looking on, furnish any assistance, as regards life, relief from pain or from deformity. For if he should wish to straighten the limbs, he can only do so by cutting and breaking those of a living man. With them, then, who are overpowered by this disease, he can merely sympathize. This is the great misfortune of the physician."

A careful analysis of this article warrants the conclusion that many conditions were confused with the disease known to us as tetanus. It is evident that Aretaeus confused cases of brain injury having convulsions, as well as cases of infectious meningitis with tetanus. No mention of treatment is contained in this article, but as time goes on we find records of how cases were treated.

As late as 1828, Doctor Marsh, at the Dublin Hospital, reports several cases of tetanus, together with his treatment. It was fallacious, as is all treatment of disease where the proper knowledge of pathology is lacking. His cases were kept in vapor baths at 90° F for five and six hours at a time, and because the moisture dissolved the crust which had formed over the original wound and made it appear cleaner, he concluded that his method was good, despite the fact that his patients all died. This is demonstrated by quotations from his article, when he says, "Notwithstanding the want of success, should we be called upon to treat other cases, we should be disposed to pursue a similar plan."

Later, in 1847, we read where cases of tetanus were purged with croton oil to eliminate toxins, and various preparations of opium used in an attempt to control convulsions. In 1848, two years after the discovery of ether as an anesthetic, an article was published by Dr E W Theobald of Boston reporting the successful treatment of a case of tetanus by vapor of sulphuric ether. Following this report, ether was used rather generally, and in many instances when the initial infection was on one of the extremities, amputations were performed to rid the patient of the focus of infection. While this may seem radical, it is in line with the accepted treatment of today, when we advocate debridement in conjunction with sedatives and even anesthetics such as avertin.

Our knowledge of tetanus continued to be meager, and treatment chaotic, until a little over 30 years ago, in 1903, when Meyer and Ransom propounded their theory as to how the symptoms were produced. They believed that in cases where only a small amount of toxin is absorbed slowly, it passes up the axis-cylinder of the nearest motor nerve and affects the anterior horn cell or its connections, and local symptoms appear in the muscles supplied by those cells. When a large amount is absorbed, the toxin passes via the perineural lymphatics into the cerebrospinal fluid, and then to the central cell, as stated above, finally affecting the entire central nervous system. They explained that the jaws were first affected because the fifth nerve was short and the toxin had less distance to travel before it reached the motor cells.

Meyer and Ransom's theory of the spread of the toxin from the clostridium tetani has persisted and has continued to be the accepted theory until John J Abel (Group I<sup>9</sup>) and his coworkers published the results of their experiment, in 1935, which appear far more plausible. They reported that by injecting dyes into the axis-cylinder under great pressure they were unable to force it into the central cell. They also report that by injecting



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the tetanus toxin into the axis-cylinder, and not allowing any to escape into the surrounding tissues, large doses failed to produce any symptoms whatever. Nor were any symptoms produced by injecting the toxin into the perineural sheath. But when they injected small amounts of this toxin into the muscle itself, after having severed all nerve supply, they produced *local* tetanus in the muscles affected by the toxin. Larger doses involved other groups of muscles, and if sufficient amounts were injected intravenously, they produced *generalized* tetanus. Therefore, they concluded that the theory of Meyer and Ransom was incorrect. They held that symptoms are produced by the direct action of the toxin on the muscle and that the spread of the toxin was through the blood stream and lymphatics. The latter collect the seminales it through the entire body and produces general tetanus. This theory is based on sound anatomic and physiologic facts and is the only plausible explanation of local tetanus. Appended is the report of a case of local tetanus which developed as local tetanus and ran its entire course to recovery as local tetanus.

**Case Report**—J. W. Mc, white, male, age 37, was first seen December 2, 1935, suffering from a laceration of the right forearm. Thirty minutes before, he had been "sideswiped" by an automobile, the door handle striking his right forearm on the lateral aspect, just below the elbow, and tearing the muscles. On examination there was a deep, ragged, transverse laceration of the lateral antibrachial muscles on the right, about one and one-half inches distal to the lateral epicondyle of the humerus. The radial nerve was exposed but uninjured. Under 1 per cent novocain infiltration anesthesia the wound and surrounding skin were cleansed with iodine and alcohol, the muscle bellies were sutured with interrupted chromic catgut and the skin with interrupted silkworm gut. A dry sterile dressing was applied, the arm placed in a sling, and 1,500 units of tetanus antitoxin given intramuscularly into the right thigh.

The postoperative course was uneventful, the wound healing by primary union, and a few cubic centimeters of clear straw colored fluid removed. On December 14—12 days after the injury—the patient complained of pain in the right shoulder associated with tonic contraction of the deltoid muscle. This continued for two days, the contraction and pain becoming more marked, and on December 16—two weeks after the injury—he was admitted to the hospital.

On admission the wound was healed, but this caused agonizing pain. There was no trismus, opisthotonos or rigidity of any of the other muscles. The reflexes were normal and the sensorium clear. Temperature 99° F, pulse 100, respiration 25. Blood pressure 110/70, R B C 5,200,000, Hb 90 per cent, W B C 13,000 with 85 per cent polymorphonuclears, Urinalysis negative.

Two days after admission to the hospital, the contractions spread to involve the biceps, coracobrachialis and brachialis muscles, and, in addition to the vertical position of the arm, the forearm was held in extreme flexion. Three days after admission, the wound was explored under ether anesthesia to determine the presence of any injury or pressure which might cause irritation to the motor nerves. No such conditions were found.

Four days after admission to the hospital, and 18 days after the injury, the contractions had spread to involve all the flexors of the wrist and fingers. The accompanying pain was intense and continuous.

The course of treatment can be divided into three stages.

(1) During the first four days of hospitalization the patient was given large and frequent doses of the barbiturates and salicylates with an occasional hypodermic of pantopon.

(2) During the next six days narcotics were given.

(3) Beginning on the tenth day avertin was given daily in doses of 100 mg per kilo of body weight for a period of four days, supplemented by occasional injections of morphia or pantopon. Thereafter the patient was kept fairly comfortable with phenobarbital.

In addition to the sedatives, narcotics and avertin, a total of 69,000 units of tetanus antitoxin were given intramuscularly, none intravenously and none intrathecally.

The patient was discharged home from the hospital January 10, 1936—25 days after admission—at which time the contractions of the deltoid and upper arm had subsided. There was still moderate contraction with some pain in the flexor muscles of the forearm, the wrist and fingers being held in extreme flexion. All muscles returned to normal one month later.

*Resume*—(1) On admission pain in shoulder with continuous, *tonic* contraction of the deltoid.

(2) Contraction of the biceps ensued two days after admission.

(3) Two days later the flexors of wrist and fingers were involved.

(4) The treatment consisted of the administration of barbiturates, narcotics and avertin.

In the literature we found 17 cases reported in private practice since the World War, but every one of them finally developed in general tetanus. The case herein cited never involved any groups of muscles except those of the shoulder, arm, forearm, and hand (abduction of shoulder and flexion of arm, forearm and hand), and the only basis upon which this can be explained is the theory reported by Abel and his coworkers, which appears to have entirely disproved that of Meyer and Ransom.

## REFERENCES

Group I comprises references relative particularly to the etiology, paths of ascent of the toxin, and types of tetanus, also the pathologic findings, Group II contains references to case reports since the War.

### EARLY REFERENCES TO THE ETIOLOGY OF TETANUS

<sup>1</sup>Carle and Rattone. *Gior d r Accad di med di Torino*, 32, 174, 1884. (First clearly demonstrated the infectious nature of tetanus by inoculating rabbits subcutaneously with pus from a human case of the disease.)

<sup>2</sup>Nicolaier. *Deutsche med Wchnschr*, 52, 1884. (Inoculated mice and rabbits subcutaneously with garden earth and found the tetanus bacillus at the site of injection.)

<sup>3</sup>Kitasato. *Deutsche med Wchnschr*, 31, 1889, *Ztschr f Hyg*, 7, 225, 1889. (For the first time grew the organism in pure culture.)

### REFERENCE TO THE DISCOVERY OF ANTITOXIN

<sup>1</sup>Von Behring and Kitasato. *Deutsche med Wchnschr*, 16, 1113, 1890. (Discovered the tetanus toxin, also the diphtheria toxin, and prepared an antitoxin, thereby laying the foundation of serum therapy.)

GROUP I—LOCAL TETANUS

- <sup>1</sup> Taylor, K P A ANNALS OF SURGERY, 74, 110, 1921
- <sup>2</sup> *Ibid* Arch Surg, 29, 923, 1931
- <sup>3</sup> Ashhurst, A P C Arch Surg, 1, 107, 1920
- <sup>4</sup> Ransom, S W Arch Neurol and Psychiat, 20, 663, 1928
- <sup>5</sup> Rabinovich, G B Klin Med, 10, 213, 1932
- <sup>6</sup> Muller, G P, and Taylor, K P A ANNALS OF SURGERY, 74, 110, 1921
- <sup>7</sup> Bruce, D Journal of Hygiene, 19, 1, 1920
- <sup>8</sup> Shimon, I G Brit M J, 2, 200, 1932
- <sup>9</sup> Abel, J I *et al* Researches on Tetanus, I Science, 79, 121, 1934, II Bull Johns Hopkins Hosp, 56, 84, 1935, III. *Idem*, 56, 317, 1935, IV *Idem*, 57, 313, 1935
- <sup>10</sup> Cushing, Thomas B A Treatise on Tetanus, London, 1836
- <sup>11</sup> Klemm, P Deutsche Ztschr f Chir, 42, 153, 1806
- <sup>12</sup> Robertson, H E. Am J Med Sc, 52, 31, 1916
- <sup>13</sup> Teale, F H, and Embleton, D J Path & Bact, 23, 50, 1910
- <sup>14</sup> Zupnik, Leo Deutsche med Wchnsch, 31, 1099, 1005, Lancet, 211, 852, 1936
- <sup>15</sup> Major, R H Classic Description of Disease, p 91

GROUP II—CASE REPORTS

- <sup>1</sup> Albert, G Thèse de Paris, 1922
- <sup>2</sup> Anschutz Deutsche med Wchnsch, 48, 47, 1922
- <sup>3</sup> Beige, A, and Azoulay, R Bull et mem Soc d hop de Paris, 46, 1074, 1922
- <sup>4</sup> Bussa, Lav E Boll d clin, 40, 113, 1923
- <sup>5</sup> Chauvin, E Progres med, 35, 362, 1922
- <sup>6</sup> Earp, S Brazil med, 40, 46, 1926
- <sup>7</sup> Guillemet and Ponzet Lyon med, 139, 633, 1927
- <sup>8</sup> Iovino, F Polichinico (sez piat), 38, 1188, 1931
- <sup>9</sup> Irwin, S T Brit J Surg, 22, 308, 1921
- <sup>10</sup> Moreali, G Riv di clin, 2, 68, 1923
- <sup>11</sup> Raul, P, and Nelson, H Bull et mem Soc nat de clin, 54, 141, 1928
- <sup>12</sup> Rodriguez, A Rev med qui, 20, 8, 1919
- <sup>13</sup> Sala, C, and Sanz, L Rev med de Barcelona, 2, 508, 1925
- <sup>14</sup> Taghavacche, N Semana med, 32, 507, 1925
- <sup>15</sup> Vaimet, F Riv crit di clin med, 24, 263, 1923
- <sup>16</sup> Vinon Bull Soc d sc méd et biol de Montpellier, 22, 168, 1921

DISCUSSION OF THE PAPERS OF DOCTORS HART, REID AND GREEN

DR HUBERT A ROYSTER (Raleigh, N C)—Doctor Reid has brought out beautifully and simply the basic principles of wound treatment. The first of these is that if antiseptics are used in wounds for killing organisms, they also kill the tissue cells. For many years we have not in our service used any so called germicides in the treatment of wounds. For the past seven years we have used a 50 per cent soap solution in sterile water, really a reliable antiseptic, not only to wash the outside but also for irrigating the inside of the wound. We do this carefully with this solution and then use a soap poultice of the same type. With this bland method, wounds have healed kindly and quickly. The colored solutions of so-called antiseptics are for the purpose of dolling up and they do no good, but possibly harm. If you have a choice between a perfectly aseptic wound with dead spaces and a wound with loose sutures and proper pressure, you will invariably choose the latter. On that account we have been using in all of our clean operative wounds what we call a pressure dressing, which exerts pressure not only from above downward but from the sides. It consists of narrow pieces of

gauze in layers which are put over the incision, with short adhesive straps crossing it. Outside this we place a large dressing, in the shape of a melon slice, which is also held in position by adhesive straps, so that we not only obtain pressure from the bottom but from both sides and above. In such cases we invariably see a considerable amount of serum collect on the outside, in the gauze, instead of in the wound. This obliterates the dead spaces with proper pressure in three directions.

DR GEORGE A HENDON (Louisville, Ky) —Anyone who has a correct conception of antiseptics will realize at once their inefficiency. The mere matter of putting an antiseptic in a wound with the object of having it come in contact with the germs is not always tenable. You cannot kill a germ unless you catch him. To think of sterilizing a wound by antiseptics is just like painting a barn to get rid of rats. Remember, the germs are buried down in the depths of the tissue. They are hidden in the recesses and remote places, and they have the mechanism of self-defense as highly developed as you or I. Keeping that phase in view, we have devised a plan for treating septic wounds and abscess cavities, which consists of a positive pressure apparatus that operates by the electric current and which forces a stream of air through a unit that is heated by electricity. The air thus heated is forced into the wound under pressure. If one so desires, a chamber containing iodine or other antiseptic can be interposed between the heat unit and the patient. The heated air volatilizes the iodine and carries it into the depths of the wound.

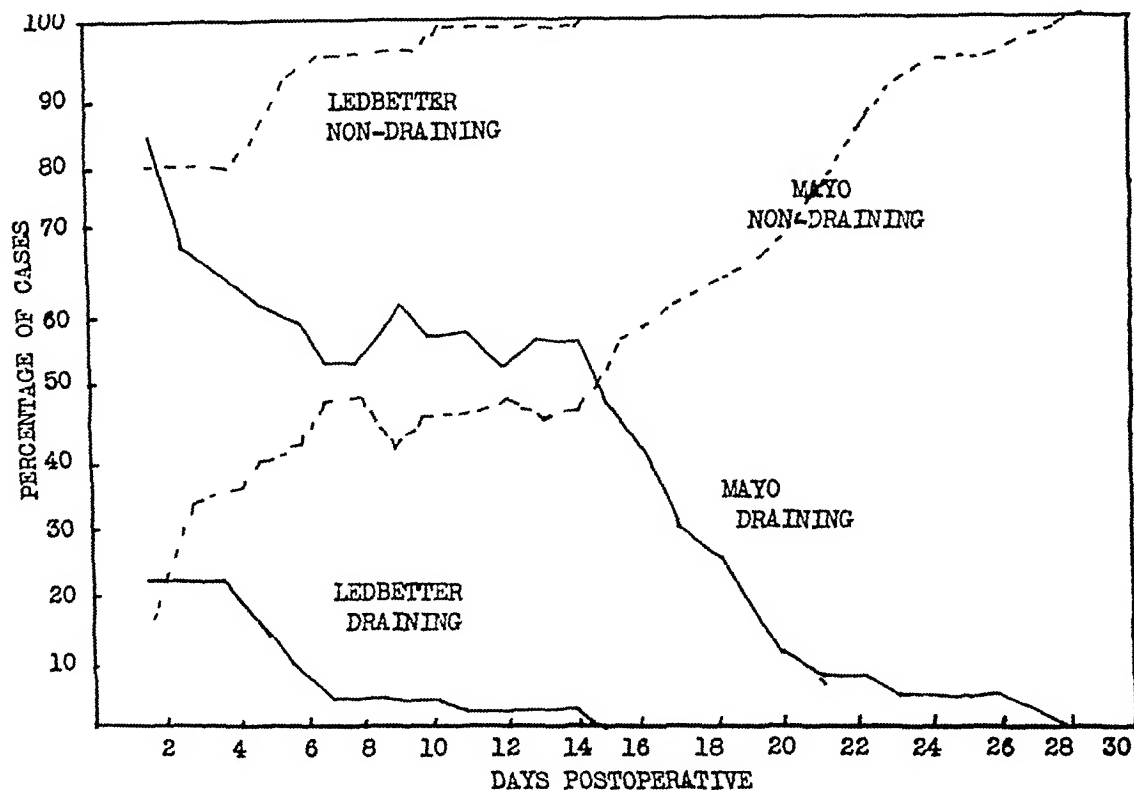
DR SAMUEL L LEDBETTER, JR (Birmingham, Ala) —I would like to briefly discuss Doctor Reid's paper. Of course, surgery would be impossible without proper wound healing and I think that we as surgeons can still go a little further in obtaining better results and getting better healing of our wounds, by paying more attention to the little details and following the suggestions as outlined by him. My only wish is that all the interns and young doctors in the country could have been present and heard him. For some time I have been comparing the difference in the healing of wounds in which silk was used with wounds in which catgut was used. Also, I have been comparing the wound healing in thyroidectomies which have been drained and those that were not drained, and have come to the very definite conclusion that when silk is used and the wound not drained, wound healing is very definitely better than when we use catgut and employ drainage.

In the December 4, 1935, issue of the Proceedings of the Staff Meetings of The Mayo Clinic, Dr H W K Zellhoefer reported some very interesting observations on the wound healing of the last 50 thyroidectomies, of their 1935 series, in comparison with the last 50 cases, of their 1934 series. In this report he stated that all cases were operated upon with local anesthesia, and all, or practically all, were drained. I was interested in comparing the wound healing in his cases in which catgut was used and in which drainage was employed with our cases in which silk was used and no drainage employed. Of course, no really fair comparison could be made, due to the fact that my 50 cases represented six months' work, or a fair average of what I was doing, and the cases he analyzed were undoubtedly operated upon in a very short period of time and possibly did not represent a fair average of their wound healing, as a large percentage of these may have been very large vascular glands, substernal adenomata, *etc*, necessitating more prolonged drainage. Chart I is an exact duplicate of his diagram upon which mine has been superimposed, and which shows very clearly the differences in the wound healing of the two technics. It will be noted that, in

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Doctor Zellhoefer's series, approximately 58 per cent of his cases were still draining at the end of ten days, the average time for complete healing was 14 days, and one case drained as long as 28 days. In my last 50 cases of the 1935 series, 40, or 80 per cent, of these were closed and only ten, or 20 per cent, were drained. Of the closed cases, none drained postoperatively, the wounds were healed within 48 hours, and all dressings removed on the fifth day. Of the wounds that were drained at the time of operation, only one drained as long as 14 days (Chart I)

CHART I



PERCENTAGE OF DRAINING AND NON-DRAINING THYROIDECTOMY WOUNDS  
DURING THE POSTOPERATIVE PERIOD IN THE 1935 SERIES OF 50 CASES

I think that the reason Doctor Zellhoefer's cases drained longer than those cases which I drained was due to the fact that we removed the drain after 24 hours, whereas he stated that they left them in from two to four days. Local anesthesia was also employed in my series. Chart I demonstrates very clearly the superiority of silk and nondrainage over the use of catgut and drainage.

DR WARFIELD M. FIROR (Baltimore, Md.)—I wish to congratulate Doctor Green on bringing to the attention of this group the work of Doctor Abel on tetanus. It has been my good fortune to assist Doctor Abel in some of this work. Some four years ago Doctor Abel, in his presidential address before the American Association for the Advancement of Science, reviewed the subject of bacterial toxins. In gathering the material for this paper he was impressed with the fact that Meyer and Ransom's theory concerning tetanus toxin was out of harmony with the known facts relative to all other bacterial toxins. Doctor Abel's curiosity was aroused, and he began a series of investigations to test the validity of the theory of nerve transportation of tetanus toxin. It might be interesting to tell you of just two of our recent experiments. In order to demonstrate the existence of local tetanus, Doctor

Abel devised a method of making multiple minute injections of diluted toxin into muscles. As little as 1/200 of a lethal dose is sufficient to cause the entire hind limb of a dog to become rigid if intramuscular injections are made in 30 or 40 different places. Such a dog remains in good health and runs around with the limb fixed in extension. The rigidity is so great that one cannot alter it even under anesthesia. After three months the muscles relax and the limb returns to normal. Recently we have tried the effect of sectioning the spinal cord on the development of this type of rigidity. Regardless of whether the cord is transected before or shortly after the intramuscular injections, the limb becomes stiff and remains so. If, however, all the nerves to the limb are divided, thus interfering with the reflex arc and destroying the tone of the muscles, no stiffness results following the injection of toxin.

The second experiment that we have performed recently consisted in injecting 1/1,000 cc of tetanus toxin into the anterior horn cells of the lumbar cord. Such an injection produces a hyperexcitable condition of the limb, the slightest sensory stimulation will precipitate a succession of forceful jerks that will last for a minute or so, until the muscles become fatigued, and then gradually subside. This type of injection does not result in a stiff leg. It reproduces, we think, the central form of the disease.

DR ALBERT O SINGLETON (Galveston, Tex) —Doctor Hart's paper deserves some discussion, I am sure. At his request we ran a series of cultures in our operating room. Before doing so we felt that we were taking the usual precautions against infection, as is commonly done in most places, and we were rather surprised to find the large number of colonies following the exposure of the media for one hour on a number of days. We found that the larger the personnel in the operating room the greater the number of colonies, and seeing that certainly impresses upon one the fact that bacteria are in the air, and in prolonged operations, particularly, many of them contaminate open wounds.

I am not sure whether his method of sterilizing the air is practicable but I am looking forward to some method which will be practicable, for I am convinced that air infection is a menace. Of course, this is not a new subject, but we had come to the conclusion that there was little danger from this source.

I visited an operating room in Copenhagen several years ago in which the floor of the amphitheater was about one inch deep in water. Everyone on the floor wore rubber boots and they were convinced that keeping down dust was very essential in lessening the bacterial content in the air.

DR CURTIS F BURNAM (Baltimore, Md) —Doctor Reid has presented, in a most instructive and convincing way, the importance of increasing resistance in surgical wounds by greater care in handling and taking care of the tissues, that this will always be a fundamental principle in surgical technic is beyond doubt.

Doctor Hart has brought us something new from the other side of the picture. I think that his charts demonstrate that the so-called aseptic fever after operations is in all likelihood a septic fever. Every surgeon is familiar with the unexplained breakdown of some incisions. In addition to the wound infections, there are, now and then, some special and unusual deep seated infections which cause death. Any work directed toward removing this source of danger, provided it does not entail impossible expense, should be given the greatest consideration. Frankly, I am surprised that, using ultraviolet light, Doctor Hart is able to kill the bacteria so quickly and that the

use of radiation of this kind over an incision does not injure the tissues themselves. However, as I have had no experience personally with this matter, I think we must remember that experience is the best teacher and that preconceived ideas must be given up in the light of actual experimentation. It would seem to me that it might be possible to sterilize the air in the operating room, and to use some form of mask for the operator and his team, which would prevent any infection from their respirations.

I feel that Doctor Reid and Doctor Hart should be congratulated on the splendid work they have done and their excellent presentation of it.

DR FRANK H. LAHEY (Boston, Mass.)—Doctor Overholt has been particularly interested in Doctor Hart's work and we are installing a similar apparatus. He has interested Doctor Wells in the department of physics at Harvard, where they are also installing an apparatus which I think may be useful. I have objected to having to operate with goggles and with my head encased. They have suggested that they put in the lights so that they throw the rays upward and this will irradiate the upper air. They think it may be possible to sterilize all the air in the operating room by exposing the upper layer of air to these rays, the motion of air eventually resulting in its all being irradiated. I do not know whether it will accomplish the same results that Doctor Hart has. We have exposed plates for various periods, and it is true that the air in all operating rooms is contaminated.

DR J. M. T. FINNEY (Baltimore, Md.)—I, too, want to pay tribute, as did Doctor Reid, to that great surgeon-teacher, Doctor Halsted. Doctor Reid has epitomized in an admirable way the principles, not all original, to be sure, with Doctor Halsted, but the fundamental principles of good surgery for which he stood and contended throughout his entire surgical life. This was one of Doctor Halsted's outstanding contributions, namely, the scrupulous observation and practice of the fundamental principles of surgery in the gentle handling of tissues, the avoidance of trauma, the stoppage of hemorrhage, the avoidance of foreign bodies in the wound, such as tissue masses that had been strangulated by ligatures, the accurate coaptation of wound edges, and the avoidance of tight sutures. It is curious how often one sees these cardinal principles being violated by surgeons all over the country, unconsciously to be sure, in the undue hurry to get through with the operation. One will at times unconsciously violate these fundamental principles if one is not constantly on one's guard. In doing so, drainage of the wound is rendered necessary when the proper observance of these rules would make it unnecessary.

I think Doctor Hart's work is deserving of great credit. I am thoroughly in favor of any advance, but I think we should stop and think as we go along, and be sure that we ourselves are not guilty in our work, of violating those principles which have been so splendidly brought to our attention by Doctor Reid. Every surgeon knows from experience that the peritoneum will take care of infection better than any of the other tissues composing the abdominal wall, that next perhaps is the muscular tissue, and that most liable to infection is the skin and subcutaneous fatty tissue. In closing infected wounds I have for some time been using instead of skin sutures, long narrow strips, one-sixteenth or one-eighth inch wide, of flamed adhesive plaster and applying these instead of sutures to hold the skin in apposition. They should be long in order to splint, as it were, the adjoining skin. By this means we can bring and hold the tissues in as exact approximation as with sutures. We have yet to see infection in a wound where these

narrow strips of flamed adhesive have been used instead of sutures. It is a small thing, of course, but it has proved most useful.

DR DERYL HART (closing) —I wish to express my indebtedness to my associates and staff for their assistance in this work, and also to those who made cultural observations for me in different parts of the country. Since there were few reports in the literature, I requested these cultures in order to confirm my impression that contamination of the air in operating rooms is quite universal, and to refute the statement that had been made that it was a local condition with us.

Referring to Doctor Burnam's discussion, it has been quite surprising to find that with such a small amount of current we could kill bacteria within a distance of eight to ten feet, and particularly that this could be done within such a short period of time. We believe that this high bactericidal effect and relatively low irritative action is due to the fact that this radiation is of a wavelength predominantly below 2,600.

As to the radiation extending upward over the operating region, as mentioned by Doctor Lahey, I hope that will work successfully, as it will simplify the matter of protection for the staff. In my opinion, the major part of the contamination of the air of the operating room comes from the personnel. The organisms given off by them will therefore be beneath the tent of rays and therefore they may get into the wound without being exposed to the radiation. This distribution of radiation may cut down the air contamination by sterilizing the air that passes within its effective range. It will not interpose an effective barrier between the wound and the source of the contamination.

I thoroughly believe in all the principles Doctor Reid brought out in his excellent paper. I do not feel, however, that we should rely upon them entirely to prevent bacterial growth in a wound if we have a method that will prevent, or greatly reduce, the inoculation of this wound. Aseptic surgery should be our ideal. Relatively atraumatic surgery should be practiced at all times, and antiseptic surgery used if the necessity arises.

DR CHARLES C GREEN (closing) —I wish to bring out one interesting fact in connection with the work of Doctor Abell and his coworkers, namely, that he has proved the statement made, in 1861, by the Norwegian, Doctor Heiberg, to be correct. At that time Doctor Heiberg stated "Tetanus is not a disease of the nervous system, but a blood disease, or blood poisoning, which has its direct effect upon the muscle tissue."

Despite this statement, however, the medical profession accepted the theory of Meyer and Ransom in 1903, but now some of the statements of Meyer and Ransom appear almost as ridiculous as the article quoted from Aetæus the Cappadocian, as, for example. Meyer and Ransom explained the stiffness of the jaws by saying that the fifth nerve was so short that the toxins traveled through its axis-cylinder so quickly that the rigidity appeared in the muscles of the jaws first. At this time that statement appears ridiculous, but how do we know that in 25 years more the things we are saying today will not appear even more ridiculous?



# THE ORIGIN AND GROWTH OF RENAL CALCULI

ALEXANDER RANDALL, M D

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FIVE thousand years before the Christian era a man died in the upper Nile Valley, and his body was prepared for burial following the custom of his day. A few years ago an English archeologist, on examining this grave, found a concretion lying among the pelvic bones, which, on analysis, was found to be composed of an outer crust consisting of calcium-magnesium-ammonium phosphate and an inner body consisting of almost pure uric acid crystals. Through the intervening seven thousand years, therefore, the chemical character of urinary calculus has remained unchanged. Likewise, the surgery of "calculus disease" enters medical history with its very beginning and, following many strange and interesting vicissitudes, comes down to us today broadly considered in all surgical writings, occupying through all time a prominent place in the surgical clinic, and hallowed by the names of all great surgeons of the past. As such it has come to be known as "calculus disease," and surgery's effort has remained little changed, interpreting its duty to be the removal of this morbid product.

It is to be part of my present effort to change this point of view, and to try to show that urinary calculus is but a symptom of a deeper underlying pathology. The problem is, without question, a complicated one. Were this not true, the etiologic factor, and perhaps a mode of cure and a method of prevention, would have been developed long ago, for much clinical investigation and serious research has been performed, as well as no small amount of logical theorization and some sheer speculation. Though we have amassed much valuable information, we still lack many important facts, and there still remain quite a number of pertinent questions unanswered.

On the one side appears the clinical state of a patient with symptoms easily recognized as arising from a renal calculus, as perhaps he is suffering his primary renal colic from nature's effort to expel such a stone, surgery intervenes, and a crystalline concretion up to 1 cm. in diameter is removed. This stone is composed of crystallized salts normally present in the urine, it is not a foreign body, it is, and it has to be, the product of some morbid process.

Contraposed to this clinical state, and in an effort to explain it, stand today five pertinent theories as to why such a stone developed. Each theory is supported by interesting and acceptable research bearing on experimental stone production, with substantiating clinical studies suggesting a close relationship between the theory and fact. It is my purpose, first, to analyze briefly these five theories and to show the fallacies of each, or at least their shortcomings. It is only fair to state that in no research to date has the

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actual origin and the growth of a stone been traced from the first deposit of a tiny crystal of microscopic size, through the stages of added salt deposition, to macroscopic size when clinical symptoms may have supervened. We have accepted the theoretical inferences whole-heartedly, and with the simple-minded attitude so aptly expressed in the famous remark of Topsy, "I just grewed."

**THE THEORY OF STASIS**—The theory is simple. That when faulty drainage causes stagnation of the urinary flow, sedimentation and crystallization of urinary salts can take place about any nidus. The picture is familiar in vesical calculus as a complication of prostatic obstruction with residual urine, and one transfers this picture to the renal pelvis, where somewhat similar conditions of urinary stasis, both congenital or acquired, do occur.

*Clinically*, the incidence of hydronephrosis with stone is well known, with pyonephrosis stone is more frequent, and one is asked to include those possible states of faulty renal drainage that theoretically accompany the necessity of being long bedridden.

*Experimentally*, such hydronephrotic conditions have been created with some success in the production of calculi, while the introduction of foreign material, as infection, regularly increases the incidence of such experimental stone formation.

**Discussion**—This theory—that stasis causes stone—though active in certain cases, fails utterly when such stasis can be proven to be absent. Also, it must not be overlooked that the finding of a stone in an hydronephrotic pelvis does not prove that the stasis caused the calculus, for often the reverse is true—that the stone came first and caused the hydronephrotic condition. Since the introduction of intravenous urography it appears that by far the larger percentage of renal calculi, especially when seen early, can be clearly proven to occur in kidneys totally devoid of stasis or faulty drainage, and in patients actively employed at normal occupations. Again, neither is it a constant fact, nor clinically is it expected, that every kidney pelvis which is poorly drained, even if infected, will sooner or later form stone, and the picture again is comparable to the occurrence of vesical calculus in prostatic disease, where, according to the highest figures published, calculus occurred in but 20 per cent. As germane to the subject at hand, let it be stated here that the material to be presented later especially excludes stasis as a factor in the etiology of stone, and in the clinical cases that will be shown only those proven to be free of stasis will be considered.

**THE THEORY OF INFECTION**—In this theory both clinical studies and experimental work come closer to a solution of the problem.

*Clinically*, we have the rather prevalent finding of infection in operative cases (which unfortunately are seen late in the disease), until an unproven axiomatic statement has gained rather general credence, "that if every case of renal calculus be traced to its ultimate end, an infection would be found underlying it." Some highly suggestive observations have been made. The prevalence of calculi as a complication in chronic infections of bone, chil-

dren with Pott's disease, long-standing osteomyelitis cases, the observations during the late war in severe bone injuries with long drainage, and similar cases in industrial surgery, all pointing to a close relationship between chronic infectious processes, especially if such have periods of exacerbation, and the occurrence of renal calculi. Of real importance is the clinical observation of the rôle that infection plays in the recurrence of renal calculi and the incrustation of urinary fistulae, especially with that group of organisms capable of breaking down urea into ammonia, causing a persistent alkaline urine and the rapid precipitation of urinary phosphates.

*Experimentally*, it is quite essential to our clear understanding of the relationship between infection and the etiology of stone to realize at the very beginning that it is almost impossible to implant an infection in the undamaged and unobstructed urinary apparatus. Even in those cases found with stone and infection present, it is faulty reasoning to assume that the infection preceded the stone. It is a uniform observation, in both clinical and experimental work, that infection always increases the incidence of stone occurrence (or recurrence) and augments the rapidity of growth of calculi. The experimental work under this theory culminates in the report of Rosenow and Meisser, where they infected the devitalized teeth of dogs and inoculated the pulp cavity with cultures of "specific" Streptococci obtained from urinary calculi, and obtained 60 per cent positive results. This work has been neither corroborated nor challenged and disproved. It stands as probably the nearest approach to the clinical picture by the purely experimental production of renal stone, though it is to be stated clearly that these authors do not actually show us how, or where, or why, a calculus develops.

*Discussion*—The theory of infection accepts such metastatic organisms as producing a pyelitic infection, and assumes that such bacteria, or their morbid products, create the nidus about which crystallization forms a stone. It does not admit that sterile cases of stone occur—which clinical studies unquestionably confirm—nor does it agree with the modern belief that organisms do not, and cannot, pass through the kidney without producing lesions. It is regrettable, on the other hand, that clinical cases too often are seen so late that secondary infection cannot be ruled out, but to anyone who cares to focus his attention only on the early cases—the small calculi, the primary attacks—it becomes increasingly evident that infection *per se* is not a part of the picture of either the clinical state of the patient, nor the laboratory studies of cultures of the affected renal pelvis. Moreover, the experimental workers have not traced the complete story from infection to actual stone formation, and have taken too much for granted between theory and fact. As will be presented later, our investigations contravert the rôle of local infection entirely.

**THE THEORY OF VITAMIN DEFICIENCY**—This theory is beginning to crystallize, under its heading, the entire rôle of diet in stone formation.

*Clinically*, it attracts attention from two distinct angles. First, and perhaps of the greatest importance, is the realization that stone of the bladder in

childhood has almost disappeared from the picture of surgery. This change has occurred within the memory of living man, and without the medical profession taking any active part in advocating steps for its deliverance from this true scourge. The figures show that one hundred years ago in Europe and America over one-half of the operations for vesical stone were performed upon children. Today these operations are a rarity, and undoubtedly the liberalization of the dietary of infancy and childhood is the sole responsible factor. Second, is the realization that it is vitamin A, and to a lesser extent vitamin D deficiency, that is responsible, causing a disturbance of the calcium phosphate ratio. The clinical importance of this knowledge is rapidly growing, especially in the field of postoperative prevention of stone recurrence.

*Experimentally*, much could be told, since 1917, when Osborn and Mendel reported their observations in rats following certain diets. Actually, no tissue suffers more severely from want of vitamin A than the epithelium lining the urinary tract (McCarrison). Epithelial degeneration, desquamation and keratinization are characteristic of the condition. In experimental animals calculi do appear in the renal pelvis, and more frequently in the bladder, the frequency of which is in direct ratio to the length of time avitaminosis is continued. Other related factors are the consistent elevation of the  $pH$  value in the urine to marked alkalinity, and the fact that the incidence of urinary infection is practically equal to that of stone formation.

*Discussion* of this theory must be confined to those factors known to be truly relevant. First, it is to be pointed out that the calculi that form under conditions of avitaminosis are consistently made of those salts known to have their normal ratios disturbed, that is, calcium-phosphate. Stones of uric acid urates, or even calcium oxalate, do not participate in the picture at all. If the phosphorus is radically diminished in the diet, calcium carbonate can be made to crystallize, and occasionally calcium and magnesium phosphate have been observed. Second, is to be noted the alkaline urine and the high incidence of urinary infection in the experimental rats, factors not unusual in clinical urologic surgery, and in keeping with our knowledge of the ready precipitation of phosphatic incrustations under such conditions. Third, it appears that the earliest formation of crystalline material is about desquamated epithelial cells acting as a nidus, and vesical stone is much more frequent than renal stone, though neither appears until marked epithelial changes have developed. It is of interest to point out the possibility that large numbers of an apparently otherwise healthy population may be living under varying degrees of avitaminosis. The perfection of the Jean's test for deficiency in visual purple, as a delicate means of estimating slight degrees of vitamin A deficiency, is a most promising clinical aid, though at present this theory must limit itself to the calcium phosphate stone as met clinically.

**THE THEORY OF COLLOIDAL CHEMISTRY**—This fascinating supposition lacks only the two essentials of tangible fact and unquestioned truth. It assumes the recognized action of colloids to hold in solution the crystalloids of the urine and, not only to hold them in solution, but in a supersaturated state

It is one of the many ingenious provisions of nature whereby it rids itself, even under physiologic conditions, of considerable amounts of excreted solid substances in the least possible quantity of fluid. The normal daily amount of colloid is sufficient for the elimination of the normal daily amount of crystalloid, but it is a delicate balance and is, therefore, assumed to be quite unstable, with a constant tendency to gain a more stable condition by having the crystalloids fall out of suspension. If one disturbs this so called colloidal balance by either increasing the crystalloid, or decreasing the colloid surface area, there occurs a precipitation of the crystalloids and their appearance in the urine as actual insoluble material. Such may be called the clinician's simple viewpoint of the intricacies of colloidal chemistry, in which one can hardly expect the physiologic chemist to wholly concur.

*Clinically*, it is pointed out that infection and epithelial degeneration are recognized disturbers of the colloid mass, either actually depreciating the amount, or causing coalescence with loss of surface area. Again into this theory will come all cases of hyperexcretory nature, where there is eliminated actually more crystalloid than there is colloid to hold it in solution.

*Experimentally*, this has been tested successfully by feeding animals excessive amounts of crystalline material, and so producing a condition of hyperexcretion. With the feeding of oxamid in large quantities, actual calcium oxalate stones have been produced, and recently Keyser (1936) has accomplished the same end by pushing calcium carbonate to the point of hyperexcretion. The remaining experimental work on the rôle of colloidal chemistry becomes so involved in theory, and so remote from clinical fact, that it bears little relation to the clinical problem at hand, though mention should be made of the suggested rôle of colloid material as the primary gel on which crystallization starts, and the colloid matrix to be found in the lamina of all calculi.

*Discussion* of this theory may be brief, for there is too little known of the intimate action of colloidal chemistry in both renal secretion and urinary excretion. Certain it is that fallacies creep in, for we all see patients with chronic phosphaturia, oxaluria and, best of all, cystinuria, who for years live with some such perverted metabolic balance and yet, even in this hyperexcretory state, fail to form stone. Moreover, this theory, though interesting in many ways, does not open any plausible lines of thought which may be subjected to experimental proof as actually causing a stone to originate. But there is to be said at this point that our knowledge regarding the colloidal balance of the urine, and the supersaturated condition in which urine is excreted, probably does play an important part in the determination of the type of salt to be deposited, once the causal factor is recognized.

THE THEORY OF PARATHYROID HYPERFUNCTION—This latest addition to the theories bearing on the etiology of renal stone is probably the most positive of all.

*Clinically*, we now know how to recognize hyperparathyroidism, and in its recognition we have an explanation relative to the disturbance in calcium

metabolism and the characteristic bony changes in generalized osteitis fibrosa cystica. The metabolic disturbance is accompanied by a high tide of calcium in the blood and an increase of calcium in the urine. At the same time there is an increased urinary excretion of phosphorus in spite of a recognized decrease of serum phosphorus. Here we have, from a spontaneous clinical state, a typical reproduction of a hyperexcretory state under which stone has been made to form in experimental animals. This is not to be passed over lightly, for renal calculus has been recognized in 65.7 per cent of the 35 cases of hyperparathyroidism studied at the Massachusetts General Hospital.

*Experimentally*, the investigative work is being rapidly pushed, for the production and utilization of parathormone have given us a valuable aid in reproducing this pathologic state. There are no details to report as yet.

*Discussion*—Valuable as this observation is, and as closely related to renal stone as it appears to be, there is lacking at present a definite relationship between parathyroid dysfunction and all urinary concretions. The disturbance is only in the calcium-phosphorus balance, and one wonders how it could play a part in oxalate, urate or uric acid calculi. In fact, the answer is again to be found in the studies at the Massachusetts General Hospital, for in a series of 300 cases of renal calculus they could prove hyperparathyroidism present in but 5 per cent.

That no one of these five theories fulfills the demands of clinical medicine and the recognized vagaries of the chemical composition of stone is the reason that each remains but a theoretical picture of the problem. Later there will be pointed out a possible relationship wherein the theory of parathyroid hyperfunction, as well as the theories on avitaminosis and that on colloidal imbalance, and perhaps that of infection, can be definitely inter-related, and perhaps found individually responsible, at times, for the causation of stone growth in the kidney. When one considers these five theories, sees their divergent angles, realizes their indisputable deficiencies and, at the same time, recognizes the varying chemistry of the stones themselves (where seven or more salts are involved and frequently present in pure or in mixed states), one feels that Howard Kelly was quite within the bounds of reason when he wrote "No stretch of chemical or physiologic imagination will permit so heterogeneous a group of compounds to be ascribed to a common origin, or their deposition, in kidney, ureter or bladder to be uniformly charged to an identical cause."

It is the purpose of this study to trace the trail that has been followed during the past seven years, working through theory to certain facts that, of themselves, created an hypothesis. From this hypothesis two postulates were drawn and the work of proof inaugurated. There has been an effort to work back to what might be called a study of calculo-genesis, the stone's conception, its embryonic growth, its fetal life cycle, up to the point where size and symptoms made it a clinical entity and clothed it with raiment familiar to surgeons.

With this background of the common knowledge on the etiology of renal calculus, we wish to point out, very briefly, the various experimental research problems that have absorbed our interest and endeavor, omitting many details for the sake of brevity, but outlining the train of reasoning that has been followed

(1) An analysis of calculi was made to determine the chemical characteristics, thinking that perhaps the problem had to be broken down into its component parts in order to determine the individual origins. It was assumed that perhaps the cause for the growth of an uric acid calculus was entirely different from that of a calcium oxalate stone, and that perhaps a different chapter would have to be written for each variety of chemical composition, with a differing etiology for each. This problem has not been productive of results. Three hundred and ten calculi have been analyzed\* and compared to the history and clinical studies without finding any specific lead between cause and effect. In this series calculi composed of uric acid, sodium urate, ammonium urate, calcium phosphate, calcium oxalate, calcium carbonate, calcium-magnesium phosphate, calcium-magnesium and ammonium phosphate, and cystine have been encountered. These studies in part have been published.

(2) We tried to infect the renal pelves of dogs by implanting organisms by cystoscope and ureteral catheter. Several exogenous and endogenous organisms were used, and when results were not forthcoming, organisms cultured from stone cases, both renal pelvis cultures and cultures from the center of calculi, were tried, but again without success.

(3) Realizing the improbability of being able to implant a culture in the healthy renal pelvis of the dog, we repeated some of these attempts, and endeavored to traumatize the renal pelvis by a wire projecting from the end of the ureteral catheter. Again success was so uncertain that the problem was abandoned.

(4) The foregoing failures taught us that a lesion was necessary to effect the implantation of an infecting agent. Twelve dogs and eight rabbits were employed. In some a pyelotomy was performed and different kinds of trauma to the pelvic walls effected by instrument, fulgurating electrode, or chemical burn. These pelves were then infected with organisms from a man who had had seven operations for recurrent urinary calculi. In others of these animals one or both ureters were opened in the middle third, and the traumatizing instrument passed to the pelvis under hand guidance, in order to keep the operative field at a distance. In this series we effected six lesions—five

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\* Of the kidney calculi, numbering 151 cases, 71 of the stones, or 47 per cent, occurred as pure salts, as follows: Calcium-magnesium phosphate, 39, calcium oxalate, 11, triple phosphate, 7, uric acid, 6, calcium carbonate, 4, cystine, 4. Of the ureteral calculi, numbering 159 cases, 100 of the stones, or 62.9 per cent, occurred as pure salts, as follows: Calcium-magnesium phosphate, 49, calcium oxalate, 39, uric acid, 7, calcium carbonate, 4, cystine, 1. The remaining 139 cases had stone or stones of mixed salts in 28 differing combinations. I am deeply indebted to Drs. H. G. Beeson, C. A. W. Uhle and P. D. Melvin for this painstaking routine study.



successful implantations of infecting organisms—and in two dogs we were able to produce visible sand or gravel. In the eight rabbits we produced six lesions, of which three held the infection, two healed, and one unhealed was sterile at autopsy. Triple phosphate sand was found in one.

(5) A group of rats were put on vitamin A deficiency diets, and a search for characteristic lesions was made. These rats were part of an extensive vitamin A problem. In some we obtained evidences of early aseptic ulcerations, but the vitamin deprivation was marked, and death occurred too early for the characteristic calcium phosphate deposits to be formed. This series is now being repeated with 96 rats at the Wistar Institute as part of a further study of the problem.

(6) During this period of experimentation clinical cases were watched, searched and studied to correlate chronic focal infections with the occurrence of renal stone, and it may be noted in passing that these studies do constantly bear evidence of such close relationship, and deductions therefrom have been published. But in this research we were unable to obtain other than the suggestive finding between theory and fact exemplified in the experimental problems or the clinical studies.

Such were some of the lines of endeavor that were pursued in the hope of finding leads which would be promising to follow in order to experimentally produce stone and allow of clinical interpretation or further study of the early changes that are creative of calculus growth. It is perhaps now evident that our entire line of thought was predicated upon the firm belief that renal stone is but a symptom, developing upon some underlying and preexisting renal pathology, and most of our efforts were bent toward making an infection the basic and fundamental primary cause.

If one divorces oneself from the plethora of theory in this field, and looks at the problem from a more detached point of view, certain questions arise that are extremely helpful to a clearer insight into the problem as a whole.

One cannot dwell upon the origin of primary renal calculus without, sooner or later, forming a firm conviction that there has to be an initiating lesion. Everything points toward it, every known fact strongly suggests it, every pertinent question demands it, and pathology itself is incomplete without it! Stone is a symptom, and not a disease entity. Stone is made from the common salts in the urine. These salts exist in a supersaturated state. Stone will grow on any foreign tissue or foreign body. Stone has got to be a gradual accretion of crystals demanding a nidus for the seeding of such crystallization. Stone requires time to grow and, therefore, must be stationary and fixed in its beginning in order to gain clinical size. Therefore, as our researches progressed, though they were unproductive of positive results, they at least seemed to help to crystallize in our minds the idea that all renal calculi must have, as a point of origin, some preexisting lesion in the renal pelvis. It was the growth of this idea—the absolute necessity of such an initiating lesion—that led us on and that suggested the above experiments with trauma and infection.



Gradually in the course of our researches there was evolved a hypothesis which, as stated, predicated the origin of any stone upon the existence of a previous lesion, and we made as our first postulate *That there must be an initiating lesion that precedes the formation of a renal calculus*. It was perfectly evident that in none of the researches on renal calculus had any one observed the actual origin, development and growth of a stone. Nowhere could be found the stages between theory and fact. Even those who had succeeded in producing calculi experimentally had not attempted to trace the actual onset and developmental stages, and practically all left one with the impression that a stone floated about in the renal pelvis while it grew in size, or else some perversion of nature nurtured this aggregation of crystals until it was at least large enough to produce a renal colic. The story of what might be called "calculo-genesis" had not yet been written.

If our first postulate demanded an initiating lesion, it naturally became evident that a second postulate would be necessary as to where such a lesion might be expected to be found. It was not difficult to exclude the probability that the simple lining epithelium of the pelvis and calices would produce the initiating lesion, their resistance is high and their anatomy and physiology are simple. The renal papilla on the other hand is quite the reverse, performing a complicated function, open to multiple physiologic variations, and known to suffer recognized insults that lead to pathologic changes. Therefore, a second postulate was formulated *That the initiating lesion was to be looked for on the renal papilla*.

A search of the literature for what is known of the pathology of the renal papilla was most disappointing. The hemorrhagic papillitis of Fenwick, the uric acid infarcts of the newborn, the calcium infarcts of Henle, and the occurrence of tuberculous ulcerations (Lieberthal) cover about all that have been recognized as primary lesions. As our experimental efforts had been abortive of results, it was decided to go to the autopsy table and, by dissecting out each minor calyx to the complete exposure of its individual papilla, to uncover whatever observations awaited us, and to hope that time, patience and industry would reward our efforts by possibly showing us lesions that could be related to stone's origin and growth and, perhaps, to the finding of early crystalline deposits. In other words, instead of trying to *create* stone by following theoretic dogma, we turned to trying to *find* stone as it occurred in man, and to observe it in its incipency, its point of origin and its causal factors. The cooperation of the Department of Pathology at both the Hospital of the University of Pennsylvania and the Abington Memorial Hospital made this effort possible and, at my request, each put at my disposal the kidneys from all autopsies, to be opened and sectioned as we saw fit. These kidneys were examined by first opening the pelvis, and from it, by careful dissection, each major and minor calyx was laid open in turn and each papilla completely visualized and studied with a

hand lens During the past six months the autopsy material from the Philadelphia General Hospital has been added, though here the kidneys have been routinely examined before we receive them

Starting in December, 1935, there have been examined to date (February 15, 1937) 429 pairs of kidneys Of this total number 73, or 17 per cent, have shown papillary lesions, either unilateral or bilateral, of one or more of the renal papillae As above stated, our interest has centered particularly about what might be called the minor pathologic changes, and kidneys showing gross destructive pathology—pyonephrosis, advanced tuberculosis, etc—are not included at all In other words, kidneys heretofore passed as having normal pelves have been the ones we particularly searched for early papillary lesions

Let me digress a moment to draw attention to two clinical observations that have been repeatedly noted by us, and which should be mentioned at this point as bearing upon this research and to a degree suggesting it First, the small calculi, which we have studied over a number of years, consistently showed a certain peculiarity, especially those whose clinical history was of short duration, evidencing that there had been but a brief interval from the time of becoming clinically obstructive to the moment when they were removed from the urinary tract Hand lens examination of such calculi regularly showed a surface highly crystalline, but also a portion which was smooth and somewhat depressed, resembling a facet This facet was so consistent in its occurrence in these clinical cases that it was early taken as suggestive evidence that the calculus had had a mural attachment Such small calculi have been photographed and enlarged, have been sectioned and polished, and the observation has been repeated so many times that it stands as quite positive circumstantial evidence of the mural origin and attachment of stone while attaining what might be called clinical size Secondly, this suggestive observation has made us study our roentgenograms more closely for the localization of small stone shadows, and since the introduction of intravenous urography, we have been pleased to find that such early calculus shadows can be proven to occur most regularly in the minor calices

Starting our postmortem series we examined 27 normals before encountering our first papillary lesion This lesion was so innocent in appearance, and yet so definitely abnormal to our previous observations, that it demanded attention There was present a cream-colored area near the tip of the papilla, which was definitely not on the surface, but appeared to be sub-epithelial Shortly thereafter we found four kidneys that showed a similar lesion—some with a solitary plaque on only one papilla, others with several papillae involved, some unilateral in occurrence, others showing bilateral papillary involvement On microscopic study, the lesion was found to be a plaque of calcium deposited in the interstitial tissue of the renal papilla, and definitely not intratubular Special stains were used to identify this as calcium, and

material has been collected by teasing out such plaques, which on being analyzed chemically was proven to be calcium\*

It is my wish at this point to especially emphasize that this lesion, as we have found it, occurs particularly in the walls of the renal papilla—some centrally placed, some just subsurface—that it is not an intratubular deposit, but a broad plaque of calcium invading and replacing interstitial tissue (Figs 1 and 2), that, from our studies, its first deposition is in the collagenous, or basement membrane of the terminal tubule walls, from which it gradually involves the intertubular spaces and causes the tubules to gradually shrink, lose their lining cells and disappear, or remain with markedly narrowed lumens, that in the many sections which we now have studied, of practically all the lesions above mentioned, in only two has there appeared cellular destruction and round cell infiltration, which could be interpreted as evidence that infection accompanied this calcium deposition. These exceptions I consider as the inevitable finding when taking such material from the autopsy table, and consider that it represents a secondary factor where infection has been implanted upon a preexisting pathologic condition.

It was not long before a kidney was found where, on such a calcium plaque, a secondary deposit of some black material could be seen. This deposit was about the size of the dot over the printed letter "i," and quite as distinctly visible (Figs 3 and 4). Sections of this specimen showed evidence that, through increasing growth and pressure, this calcium plaque had lost its epithelial covering, and on its surface was deposited a layer of some different material. Its minute size defied analysis and specific staining methods, but from our subsequent studies we now look back upon this tiny speck as the earliest evidence of renal calculus formation ever seen.

Our next important step arrived with the examination of a kidney in which a small stone was found, which was, however, unfortunately dislodged by the knife as the kidney was opened, search, however, revealed another papilla which contained a visible calcium plaque, upon and from which a second stone projected into the lumen of the minor calyx (Figs 5 and 6). This stone was firmly adherent, measured approximately 2 Mm in diameter,

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\* Dr James H. Jones of the Department of Physiologic Chemistry of the University of Pennsylvania analyzed 4.65 mg. of such material for me, to find calcium to occur in 4.967 per cent (5 per cent). As muscle, liver, lung and kidney contain only 0.1 to 0.5 per cent, it left but little doubt that calcium was present in high concentration. Dr Charles G. Grosscup of the Abington Memorial Hospital, with 1.9 mg. of material, similarly composed of plaques teased from visible papillary lesions, undertook a quantitative analysis. He reports that the material was microcrystalline and chalky in appearance, was insoluble in water and acids, but dissolved in alkalis. Quantitatively calcium was present in 19 per cent, nitrogen in 10 per cent, CO<sub>2</sub> in 1 per cent, and phosphorous present but difficult to make accurate quantitative estimation. He states, "In view of the low CO<sub>2</sub> and phosphorus content and high calcium (19 per cent), it was evident that about 80 per cent of the calcium must be bound in some other form. With the murexide test indicating xanthine, the insolubility of the material in acids and the high nonprotein nitrogen suggest that this may be nucleic acid."

and resembled in appearance the larger calculus which the knife had dislodged. Study of these specimens has been most valuable in the first place the dislodged stone has been analyzed and proven to be composed of calcium phosphate, microscopic sections of the smaller, adherent stone have demonstrated unquestionably that it is growing from, and is supported by, a typical calcium plaque imbedded in the wall of the renal papilla, special stains have shown that the stone is of calcium phosphate, while the plaque itself is composed of calcium but does not show phosphate as a salt. So here we have a definite renal calculus growing on an initiating lesion, and the lesion is a deposition of calcium in the walls of the renal papilla, and the two are of different chemical composition. The demonstration of this fact becomes a most vital factor in our conception of the origin of renal calculus, and should be emphasized. Here, for the first time, we find a lesion of not infrequent occurrence (17 per cent), and of rather constant character and chemical composition. This lesion, innocent enough while buried in the wall of a renal papilla, can lose its epithelial covering and from then on be bathed in calyceal urine, and acting as a foreign body, it becomes the nidus upon which urinary salts precipitate. Here, likewise, we can picture the reason how and why renal calculi can remain stationary while increasing in size. Here we can account for a common origin of stone formation, which also allows of the known variation of salts so deposited to form stone, and one can assume that the salt which does crystallize to form a calculus is the one which, at that epoch, is most readily thrown out of suspension. Study of the serial sections through this stone has likewise shown us, at the edge of the plaque, a definite elevation of the plaque by the encroachment of crystallization, which suggests that when a stone becomes free, it does so by tearing the plaque from its tissue bed and taking it away with it.

From this point on our studies have taken a variety of directions. We have observed to date 14 kidney specimens, in which calculi have been seen growing upon papillae. Eight of these have had a single stone present, in five of them two papillae were found with stones adherent, and in one case all six papillae supported stone deposits. This makes a total of 24 observations where calculi have been found actually adherent to, and growing upon, a renal papilla. To these may be added four other specimens where the calculus was less than 1 Mm in diameter, but which were as plainly visible

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FIG 1—Drawing of a typical subsurface calcium plaque in the wall of a renal papilla.

FIG 2—Detailed drawing of high magnification of a subsurface calcium deposit on the renal papilla. Note the shrunken tubules at the base of the plaque, their loss of normal epithelium, and the absence of any reaction suggesting infection.

FIG 3—Colored photograph of a renal papilla, showing the subsurface calcium deposit and in its center a tiny black secondary deposit. This the earliest evidence of secondary deposit which forms stone.

FIG 4—Colored photomicrograph of Fig 3, showing the calcium plaque which has lost its covering mucosa, and on which is a secondary deposit of brown material, taken to be the earliest evidence of renal calculus formation. No evidence of infection.

FIG 5—Colored photograph showing calcium deposits in two papillae and a stone attached and growing on the calcium deposit in the third papilla. Another stone of similar character found in this kidney has been analyzed and proven to be composed of calcium phosphate.

FIG 6—Colored photomicrograph of Fig 5, showing the papillary stone attached to its calcium plaque. The differential staining shows the stone composed of calcium phosphate. The plaque with some phosphate staining, counterstains for calcium of different composition. No evidence of infection.

1

(x2)

3

(x2)

←(SEE OPPOSITE PAGE FOR LEGEND)



as a cinder on the cornea of the eye. Each of these has been sectioned and this earliest deposit proven microscopically.

It has been our purpose to try to demonstrate that each of these calculi was supported by a primary intrapapillary calcium plaque as its initiating lesion. That this is exceedingly difficult will be readily understood. In the first place such calculi have to be properly decalcified before sectioning—not completely decalcified, of course, but enough to allow sectioning—and in doing this we have lost specimens. Again, we have tried to depend upon special stains in an effort to differentiate the various possible salts, which has required special methods of tissue fixation. This, in turn, has dissolved some specimens, and others have been made so brittle as to be completely fragmented on sectioning, and this has resulted in the loss of some specimens. In addition, it has been difficult, and most tedious, to attempt complete serial sectioning of stones 6 and 8 Mm in diameter, in order to cut through the stone and its possible underlying plaque, which frequently is minute and generally eccentrically placed. In order to avoid these disappointments, two other procedures have been adopted in order to prove that each calculus arises from a calcium plaque in the wall of a papilla. First, a few selected specimens have been subjected to tissue-clearing methods, and by this means we hoped to visualize through the cleared papillary wall the underpinning of the calculus upon the papilla's surface. The second method was discovered accidentally, when a tiny black stone, 3 Mm in diameter, was inadvertently dislodged, on examining it under a strong lens, it was seen to be distinctly composed of a black mass with a bossed surface, simulating the early jackstone development of the calcium oxalate stone, but to one surface a clear-cut white layer was adherent, distinctly different and definitely crystalline. This we inferred to be the calcium plaque. Through the cooperation of Dr. A. Newton Richards these two layers were analyzed separately. The calculus weighed 5.5 mg (Fig. 7). Microchemical analysis was made, which showed that the white layer, or plaque, was composed of calcium carbonate, with a decided trace of calcium phosphate. The black stone gave a negative test for calcium carbonate, calcium phosphate and uric acid, but was conclusively proven to be pure calcium oxalate. This is a most significant finding, for here again, on a papillary plaque composed of calcium carbonate and calcium phosphate, a stone composed of a different salt has formed (calcium oxalate). Two other calculi of similar character have been gently dislodged from their papillary attachments, and in each case the white plaque is plainly visible. This, to a degree, supports the assumption that as a calculus is extruded in life, it gains its freedom by tearing away its supporting plaque from its original tissue bed.

While these researches have been furthered in an effort to substantiate the idea of a papillary initiating lesion, and to quite definitely prove the rôle played by the finding of the calcium plaque formation and its relationship to the clinical occurrence and growth of a renal calculus, we have been keenly interested also in trying to solve the *raison d'être* of the deposition of cal-

cium in the papillary wall This work is far from finished, but it is possible, at the present time, to give the pathology as we have interpreted it I am obliged especially to Dr John Eiman, Pathologist to the Abington Memorial Hospital, for the following detailed description and to Dr Balduin Lucke, Professor of Pathology, University of Pennsylvania, for his interest and aid in obtaining special staining methods and in section cutting, as well as his coincidence with the opinions expressed on the microscopic pathology

**MICROSCOPIC PATHOLOGY—Normal Papilla** The normal papilla is covered by cells which differ from those lining the calices and the collecting tubules, in that they are a single layer of flat, very thin cells which are modified cells of the lining epithelium of the collecting tubule The collecting tubules in the papilla vary considerably in diameter, the larger ones, or the ducts of Bellini in the area cribosa on the apex of the papilla, measuring from 100 to 200 microns in diameter The cells lining the collecting tubules are arranged as a regular single layer, with their nuclei at one level and their free surfaces bulging slightly into the lumina The smaller collecting tubules are lined by sharply defined cuboidal cells As the collecting tubules grow larger, the cells become higher and in the ducts of Bellini acquire a tall columnar form The epithelium of the collecting tubules rests upon a well developed and distinct basement membrane The interstitial connective tissue in the papilla is more abundant than in the cortex and medulla of the kidney, and there is an abundant amorphous ground substance

**The Calcium Plaque** Figs 1 and 2 (Specimen No 36-7, U of P) Approximately midway between the tip and the base of the papilla, underneath the epithelial covering, is an area, measuring 2.5 Mm in length and varying from 0.1-0.3 Mm in width, composed of dense connective tissue The surface of the papilla over this area is somewhat irregular The blood vessels in this location are less numerous, and those present are partially obliterated by the surrounding dense connective tissue Some of the collecting tubules are devoid of lining epithelium, while other tubules show cells evidencing degenerative changes In the portion of this region nearest the tip there are a number of small areas showing granular detritus In this location are seen two small irregular deposits of purplish-staining material (H and E) measuring approximately 0.3 by 0.03 Mm By special staining methods\* these deposits proved to be calcium These calcium deposits, or plaques, are separated from the surface of the papilla by a thin irregular layer of connective tissue and covering epithelium Where the calcium is less dense it occurs in rings, definitely deposited in the basement membrane and spreading into the ground substance of the surrounding connective tissue

Throughout the papilla, but especially near the tip, there are areas showing an increase of interstitial connective tissue Some of the blood vessels show narrowing and irregularity of their lumina The cortex and medulla show no noteworthy lesions The walls of the convoluted tubules show no calcium deposits The larger vessels show a moderate degree of arteriosclerosis There is no microscopic evidence of infection in this specimen

(Specimen No 36-42, U of P) Near the tip of the papilla is a calcium deposit measuring approximately 0.3 by 0.3 Mm It is separated from the surface by a layer of connective tissue and covering epithelium varying in thickness from a few strands to 0.6 Mm The surface of the papilla shows a practically normal covering except at one point near the plaque where there is a depression about 0.5 Mm deep Most of the collecting tubules near the plaque are devoid of their epithelial lining, but an occasional tubule shows small clumps of partly degenerated and desquamated epithelial cells Blood vessels near the calcium plaque are diminished in number, they are distorted and show various degrees

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\*The special stains used in this study are von Kossa, Eros, Giemsa, Masson, azo-carmin, elastic tissue stain, Grandis and Maimni, methylene blue, and picric acid stain for urates and uric acid



of compression to the point of obliteration. Around the dense calcium plaque are seen ring-like deposits of calcium in the basement membrane of the tubules. There is no microscopic evidence of infection in this specimen.

*Fully Developed Initiating Lesion* Figs 3 and 4 (Specimen No 36-43, U of P) Near the tip of the papilla there is a loss of continuity of the surface with the formation of a shallow depression. In this depression is situated an irregular plaque, measuring 0.6 Mm in length and from 0.1-0.2 Mm in width, which by special stains was proven to be calcium. The plaque shows numerous small, roughly rounded spaces which vary in size. Over the surface there is an irregular layer of brownish material which measures 0.025 Mm in thickness, this layer is definitely of different material than the calcium plaque. The calcium plaque is not uniform in texture, in the looser parts about the periphery the calcium is seen deposited in the basement membrane of partly compressed collecting tubules. There are a few tubules which show deposition of calcium in some of the lining cells, while other cells are completely preserved.

Special stains show that when the calcium is to be deposited, it appears to be laid down first of all as fine granules in the basement membranes of the collecting tubules. With further deposition such granules coalesce until the calcium appears as a complete ring encircling the tubule, generally with loss of epithelial lining, though occasionally there can be found some viable cells. From this point, calcium is further deposited in the ground substance of the surrounding connective tissue, with gradual generalized coalescence and plaque formation. There is no evidence of a deposition of calcium in the epithelium of the convoluted tubules.

Near the plaque and at the tip of the papilla are seen many large, roughly rounded, irregular spaces, many of them devoid of epithelial lining, but some showing epithelial cells in different stages of degeneration. These large spaces undoubtedly are cross sections of large collecting tubules or ducts of Bellini that have lost their normal epithelial lining. Toward the base of the papilla the dilatation of the collecting tubules is less marked, and the lining shows consistently larger numbers of epithelial cells of lesser degrees of damage. There is no microscopic evidence of infection in the specimen.

This we have termed the fully developed initiating lesion, for here we see, for the first time, a secondary deposit of entirely different staining properties laid down in laminae upon a simple calcium plaque. The essential point being that this plaque has lost its connective tissue and epithelial covering.

*Calculus on Plaque* Figs 5 and 6 (Abington No 1) Near the tip of the papilla, 0.3 Mm beneath the surface, there are irregular calcium deposits over an area 2.2 by 0.6 Mm. Near these deposits, on the surface of the papilla, there is an irregular calcium plaque measuring approximately 0.4 by 0.1 Mm. To the outer surface of this calcium plaque, and only to the plaque, is attached an irregularly shaped calculus measuring 1.75 by 0.8 Mm. This stone, by special staining methods, was proven to be composed of calcium phosphate, while the plaque on which it grows stains for calcium but not for calcium phosphate.

Here is microscopic evidence of a calculus of one chemical composition growing from the surface of an intrapapillary plaque of a different chemical composition.

*All Lesions on One Papilla* (Specimen No 32-682, U of P) This papilla shows a number of subsurface lesions. Near the surface on the side of the papilla there is a small roughly oval area, homogeneous in appearance, composed of dense connective tissue and showing very few partly degenerated nuclei. Close by, in a similar subsurface location, is a small necrotic area separated from the surface by connective tissue and covering epithelium. A short distance from this necrotic area toward the tip of the

papilla is another area of necrosis showing deposition of calcium, yet still separated from the surface of the papilla by three or four strands of connective tissue cells. Still further toward the tip of the papilla is seen a small depressed area devoid of normal covering, with irregular fragments of calcium deposit at its base. Apparently something has been torn away from this area, carrying with it part of the calcium plaque. In no place is there any evidence of infection, or of calcium deposits in the convoluted tubules.

This section pictures a most fortunate find, for from this papilla we removed a black stone and on it have demonstrated its attached plaque (Fig 8). Also, as described above, are demonstrable in this section (a) An undisturbed subsurface calcium plaque, (b) an area of necrosis as yet without calcium deposition, and (c) the earliest changes of simple fibrosis with some pyknotic nuclei (Fig 9).

**DISCUSSION**—The general impressions obtained by a close study of these specimens are: That there occurs a definite damage to the epithelial lining



FIG 7—Calculus found attached to a renal papilla, which was manually removed. The specimen weighed 5.5 mg and measured 3 mm across. The black stone has been proven to be composed of calcium oxalate; the white portion is the torn out plaque from which the stone developed and is composed of calcium carbonate and phosphate.



FIG 8—Tiny renal calculus removed from a renal papilla (Spec 32682). The calculus weighed approximately 1½ mg and measured 1 mm. This greatly enlarged photograph shows the black calculus and its firm attachment to the white calcium plaque, which was torn out of its tissue bed on removal of stone.

of the collecting tubules, and that the nearer one goes toward the tip of the papilla the more noticeable the changes are, that there is a marked damage to the ground substance of the interstitial connective tissue and of the basement membrane of many of the collecting tubules. Here and there the ground substance is broken up and granular, and has a necrotic appearance. These changes appear to be followed by the deposition of calcium and calcium plaque formation. This study also reveals that in places the calcium is deposited in damaged epithelium of the collecting tubules, but the primary deposit appears to be in the basement membranes leading to the formation of ring-like structures. No evidence of infection is seen in any of the sections presented.

Mention should be made of five specimens in which this simple pathologic process shows additional features. In two of these five specimens the presence of bacteria has been demonstrated. Whether these are secondary in-

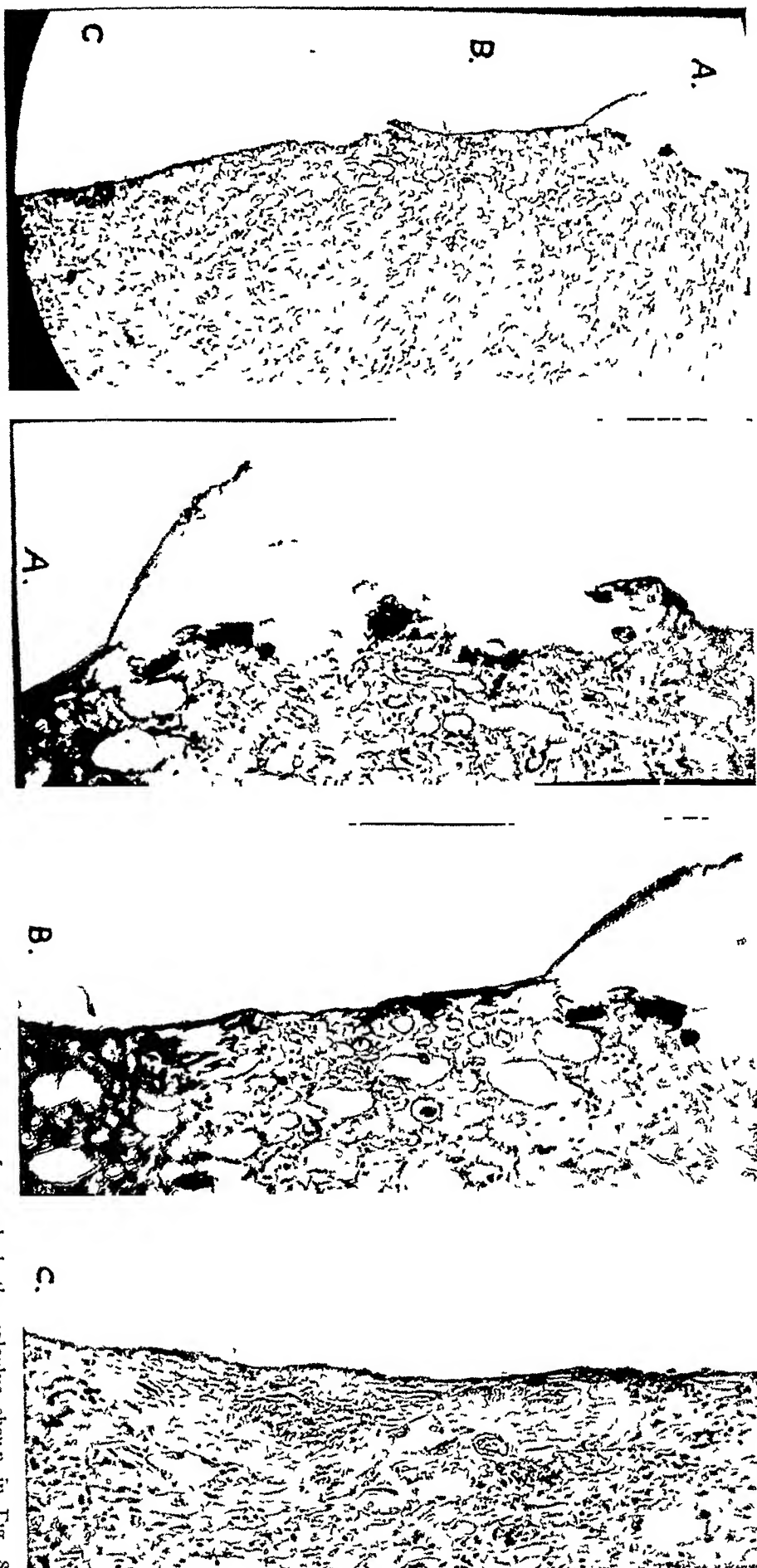


FIG. 9.—All lesions on one papilla. On the left is a photomicrograph (low power) showing at A an area from which the calculus shown in Fig. 8 was removed. At B is a subsurface calcium deposit while at C is an area of ischemic and necrotic. Succeeding pictures are these three areas under higher magnification.

vaders, or play a more important rôle in the papillary pathology, we are not prepared to state at present. It is certain, however, that the tissue changes and the pathologic processes seem to be fundamentally the same, and the entire picture impresses one as a more rapidly progressing lesion, a more generalized involvement of the papilla, and it is to be noted that each of these patients died from a septic condition. All five of these specimens show multiple papillary involvement, with yellowish to brownish streaks running in converging lines toward the tip of the papilla. Microscopically are to be seen marked tubular damage and massive deposits of calcium phosphates and some urates. We recognize in this a picture similar to that originally described by Henle and thought by him to be (tubular) calcium infarction, a view later modified by Lubarsch who showed that the calcium deposition was also extratubular. Neither of these authors in any way attributed his observations to be related to renal calculus formation, but it is to be recorded that one of our cases in this group had two small renal calculi, composed of calcium phosphate, attached to separate papillae. We concluded, therefore, that though this group represents a rare form of papillary pathology, it nevertheless is essentially the same process and is related to the origin of renal calculus.

With this interpretation of the pathology as unfolded on microscopic study, our researches naturally led to an effort to determine the basic cause for such degenerative changes. We are not ready, at present, to draw any conclusions from these studies, but the picture would not be complete unless mention were made of our ideas and the direction of our efforts. First, by reverting to the five theories relative to stone origin, we have undertaken to try to produce hyperparathyroidism by the giving of parathormone, and a group of dogs are undergoing such administration, to be sacrificed at selected intervals and their renal papillae studied. Secondly, a large group of rats are on vitamin A deficient diets, who are to be sacrificed at earlier intervals than in other studies, in order to determine the possible occurrence of early lesions. Thirdly, the rôle of infection *per se* is to be studied, both as to specific organisms and in further tissue studies which we are watching, but we are particularly interested in certain phases of toxin action as divorced from actual tissue infection. It will be of the greatest interest to see which, if any or perhaps all, of these previously suspected etiologic factors play a part in causing the initiating lesion which we are describing.

#### CONCLUSIONS

(1) An hypothesis has been formulated that renal calculus formation is dependent upon a preexisting renal lesion. Our studies conclusively point out that this is true, and that calculo-genesis is but a symptom of some form of renal papillary damage antedating the deposition of crystalline urinary salts.

(2) This hypothesis placed the expected lesion upon the renal papilla.

Microscopic studies have shown a hitherto unrecognized papillary lesion, consisting of the deposition of calcium in the walls and intertubular spaces of the renal papilla, which lesion has been observed in 17 per cent of the 429 pairs of kidneys studied at autopsy

(3) To date, 28 specimens of renal calculus formation have been observed as growing upon, and actually adherent to, the renal papilla

(4) In seven specimens we have been able to prove conclusively that the calculus was intimately attached to this calcium deposit, and to show that once the calcium deposit lost its epithelial covering it was subjected to a constant bath of calyceal urine, from which it is naturally assumed that crystals were deposited as upon any foreign body

(5) We report the positive evidence that cases of calcium phosphate stone and of calcium oxalate stone have been proven to grow from such calcium plaque formation, and that in each of these cases the salt deposited as a calculus was of different chemical character from the plaque to which it was attached

(6) It is shown that such calcium plaques appear to be a natural reparative process to some form of tubule damage, the occurrence of which is in much higher incidence than the actual clinical frequency of renal stone

(7) The most significant conclusion to be drawn from this research is that the answer to the secret which has shrouded in mystery the true etiology of primary renal calculus is to be sought in an increasing knowledge of the physiology and pathology of the renal papilla

## ORGANIZATION OF THE AMERICAN BOARD OF SURGERY COMPLETED

IN ANSWER to the widespread demand for an agency which will attempt to certify competent surgeons, the American Board of Surgery has recently been organized. This Board is a member of the Advisory Board of Medical Specialties which includes all of the boards of certification for the different medical specialties which have been already organized. Since boards were in existence for the certification of practitioners of some of the surgical specialties such as ophthalmology, otolaryngology, obstetrics and gynecology, genito-urinary surgery and orthopedic surgery, it is expected that the American Board of Surgery will be responsible for the certification of general surgeons as well as those practicing in the remaining specialized subdivisions of surgery.

Acting upon the invitation of the American Surgical Association, the following surgical societies cooperated in the creation of the American Board of Surgery: the American Surgical Association, the Surgical Section of the American Medical Association, the American College of Surgeons, the Southern Surgical Association, the Western Surgical Association, the Pacific Coast Surgical Association, and the New England Surgical Society. The first three of these bodies which are national in scope have three representatives on the Board. All of the other societies have one representative each. The representatives of the cooperating societies are nominated by the society which they represent and upon approval of the Board shall become members of it. The term of membership on the Board will be six years. The following were chosen to represent the cooperating surgical societies:

DR EVARTS A GRAHAM	}	Representing the American Surgical Association
DR ARTHUR W ELTING		
DR ALLEN O WHIPPLE		
DR DONALD GUTHRIE	}	Representing the American College of Surgeons
DR ERWIN R SCHMIDT		
DR HARVEY B STONE		
DR FRED W RANKIN	}	Representing the Surgical Section of the A M A
DR HOWARD M CLUTE		
DR J STEWART RODMAN		
DR PHILEMON E TRUESDALE		Representing the New England Surgical Society
DR THOMAS ORR		Representing the Western Surgical Association
DR ROBERT PAYNE		Representing the Southern Surgical Association
DR THOMAS JOYCE		Representing the Pacific Coast Surgical Association

The following officers were elected:

*Chairman*—DR EVARTS A GRAHAM

*Vice-Chairman*—DR ALLEN O WHIPPLE

*Secretary-Treasurer*—DR J STEWART RODMAN

Two groups of candidates are recognized for qualification by the Board:

- (A) Those who have already amply demonstrated their fitness as trained specialists in surgery
- (B) Those who, having met the general and special requirements exacted by the Board, successfully pass its qualifying examination

The first of these groups, the Founders Group, upon invitation by the Board will be chosen from the following:

- (1) Professors and Associate Professors of Surgery in approved medical schools in the United States and Canada
- (2) Those who for 15 years prior to the Board's organization have limited their practice to surgery

- (3) Members of the American Surgical Association, the Southern Surgical Association, the Western Surgical Association, the Pacific Coast Surgical Association and the New England Surgical Society, who were in good standing January 9, 1937

All applications for the Founders Group must be received within two years of the Board's organization, January 9, 1937. No candidates for the Founders Group will be considered after that date.

Requirements for those to be qualified by examination will be as follows:

- (1) Graduation from a medical school of the United States or Canada recognized by the Council on Medical Education and Hospitals of the A. M. A. or graduation from an approved foreign school.
- (2) Completion of an internship of not less than one year in a hospital approved by the same Council, or its equivalent in the opinion of the Board.
- (3) *Special Training*. A further period of graduate work of not less than three years devoted to surgery taken in a recognized graduate school of medicine or in a hospital or under the sponsorship accredited by the American Board of Surgery for the training of surgeons. This period of special training shall be of such character that the relation of the basic sciences of anatomy, physiology, pathology, bacteriology and biochemistry is emphasized. Knowledge of these sciences as applied to clinical surgery will be required in the examination. Adequate operative experience in which the candidate has assumed the whole responsibility will be required. An additional period of not less than two years of study or practice in surgery.
- (4) The candidate must present to the Board sufficient evidence of good moral character as to justify it in the belief that he will not engage in fee splitting and other dishonest practices.

It is expected that the Board, with the assistance and cooperation of the American Medical Association and the American College of Surgeons, will be able to increase the facilities which now exist for the adequate training of young surgeons by means of residencies, fellowships, etc., in suitable hospitals.

The above requirements, especially those referring to surgical training, are subject to change from time to time as the existing opportunities for training in this field of specialization may be broadened.

The qualifying examination will be divided into two parts. Part I, written, and Part II, clinical, bedside and practical. The written part, Part I, will concern itself with general surgical problems and with the clinical application of the basic sciences of surgery to these problems. This examination will cover a period of three hours each and will be held simultaneously in as many centers as are necessary to accommodate the number of applicants who are eligible. Part II is entirely oral and will also concern itself, in the main, with general surgery and, as stated for Part I, clinical application of the basic sciences to the clinical problem represented. In addition to this, in Part II, an examination will be given to test the candidate's knowledge of operative surgery, roentgen ray film interpretation and the principles and application of surgical anesthesia. This examination will be held in as many centers as the Board may determine necessary to accommodate the eligible candidates. Reexaminations will be allowed providing one year shall elapse between examinations.

The fee for Group A, the Founders Group, shall be \$25. The fee for Group B shall be \$75, payable as follows: \$5 for registration fee, which shall be returned if the candidate is not accepted for examination, \$20 for Part I, and \$50 for Part II. The same fee will be required for each reexamination. Once the candidate has become qualified, he will have no further financial obligation to the Board.

This Board is a non-profit organization. All fees will be used, after a reasonable

amount is set aside for necessary expenses in maintaining its office, conducting examinations, *etc*, to aid in improving existing opportunities for the training of the surgeon

A certificate attesting to a candidate's qualifications in surgery after meeting the requirements of the Board will be issued, having been signed by its officers

Any certificate issued by the Board shall be subject to revocation by the Board at any time in case it shall determine in its sole judgment, that a candidate, who has received a certificate, either was not properly qualified to receive it or has become disqualified since its receipt

The Board will hold its first examination (Part I, written) on September 20, 1937. All inquiries concerning applications for this examination should be received by the secretary's office promptly

Requests for booklets of information, application blanks, and other information should be addressed to the Secretary—Dr J Stewart Rodman, 225 South 15th St, Philadelphia, Pennsylvania

J STEWART RODMAN, M D  
*Secretary*



## EPHRAIM McDOWELL MEMORIAL

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For some years you have been good enough to continue me as a committee of one to cooperate with the Kentucky State Medical Association in securing the Ephraim McDowell home for conversion into a permanent shrine. Until now I have been unable to report progress, but am happy to state that the project is in process of completion. In May of 1935, the Kentucky State Medical Association erected a memorial to Jane Todd Crawford, the patient upon whom Doctor McDowell performed his epoch-making operation. At this meeting the then President of the Kentucky State Medical Association appointed a Committee consisting of Drs. A. T. McCormack, Marshall McDowell, Louis Frank, Charles Vance and Irvin Abell to negotiate for the purchase of the property and to raise funds for its payment. I am happy to report that the property was purchased by the Kentucky State Medical Association, November 22, 1935, and in turn deeded to the Kentucky State Department of Public Property under supervision of the State Parks Board. This latter was done in order to secure an appropriation from the P. W. A. of \$13,500 for restoration purposes. To the purchase price of \$15,000 the then owners of the property contributed \$5,000 as a memorial to their father, the late Doctor Wiesiger, leaving \$10,000 to be raised in donations from the profession of the country. I am glad to state that this amount has been fully subscribed and particularly pleased to note that 51 members of the Southern Surgical Association have contributed \$3,230 to the fund, this does not include the donations of the Kentucky members of the Southern Surgical Association, since these naturally have been listed with those from the members of the Kentucky State Medical Association. Our books are still open in the hope that we will secure additional funds for the purpose of purchasing an adjoining piece of property which investigation shows to have been Doctor McDowell's Apothecary Shop, and further for the erection of a statue of Doctor McDowell in the garden of the home.

The work of restoration began August 10, 1936, and we are hoping to have it completed during the coming year. By deeding the property to the Kentucky State Department of Public Property, the perpetuity of the Memorial is assured. As this has become known, we have been able to secure mementoes and relics of Doctor McDowell for preservation in the home.

IRVIN ABELL

# MEMOIRS

WILLIAM OLIVER FLOYD

1880-1936

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AT THE 1935 meeting of the Southern Surgical Association at Hot Springs, Doctor Floyd was taken ill with influenza, which culminated in pneumonia, from which he died January 12, 1936, at the age of 56. He was well known as a surgeon throughout his native state of Tennessee and



WILLIAM OLIVER FLOYD M.D.

contiguous territory, a man of ripe judgment and sincere devotion to duty, and particularly solicitous about the welfare of his patients.

He received his Bachelor of Science degree from Peabody College in

1907, and was graduated in medicine from the University of Nashville in 1910. He interned at St. Thomas Hospital and after that had been identified with it continuously as Assistant Surgeon and later Visiting Surgeon, the day of his death marking the completion of his year's service as President of the Staff. He was a Fellow of the American College of Surgeons and had been a member of the surgical staff of Vanderbilt Hospital and the Nashville General Hospital. He was one of the assistants to the Chair of Surgery at Vanderbilt University.

Doctor Floyd was a man of unusual common sense, the basis certainly of all scientific and practical surgery. With increasing experience he developed a ripe surgical judgment, any error was always on the side of conservatism. He never did anything questionable or risky for a patient if he could avoid it. From a large volume he remembered the essentials and profited by every item of experience. He was slow to take on the new, but he held to the well-tried. He was really at his best during the emergencies that arose during the course of an operation, always cool, deliberate, but extremely resourceful. In diagnosis he had an uncanny faculty for picking out the important and sorting it out from the nonessential. He never lost sight of the most probable explanation of the condition. Being a man of rare discernment he was able to winnow the functional from the organic and was never allured by the neuasthenic.

His interest in roentgenology was early and at all times sustained. He had the unusual opportunity of comparing all of his roentgenologic studies of the viscera with the pathologic condition found at operation, which is a rare combination and which he utilized to the full. This gave his interpretation of roentgenograms exceptional value.

While very unobtrusive, Doctor Floyd was sincere and dignified, so that those who knew him came to love him and admire him as a man of character, inherent honesty, and rare conscientiousness. He was patience personified. Disraeli said, "Patience is a necessary ingredient of genius." These attributes, together with his tolerance and imperturbability, made him a splendid type of surgeon. The esteem in which he was held was most unusual and an example of what honesty, steadfastness of purpose, and high ideals in surgery will accomplish.

He made a number of contributions upon diseases of the gallbladder and ducts. In a large experience he encountered many bizarre and unusual cases which were reported. He had written upon the surgical conditions of the colon, goiter, and made a comprehensive study of the end-results in our cases of breast cancer.

Doctor Floyd never sought a confidence, but if it were given to him he held it inviolate.

In a memorial tribute his colleagues said of him, "In his blood ran the essence of humanitarianism blended with skill and understanding To the many his ministrations dispelled despair and became a beacon of hope and renewed energy As a man he lived simply but richly, he thought clearly and without prejudice, he was modest and unostentatious He served justice and spoke no evil "

WILLIAM D HAGGARD

## CHARLES JEFFERSON MILLER

1874-1936

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"His wise, rare smile is sweet with certainties,  
And seems in all his patients to compel  
Such love and faith as failure cannot quell,  
We hold him for another Herakles,  
Battling with custom, prejudice, disease,  
As once the son of Zeus with Death and Hell"—*William Ernest Henley*

It is difficult for one closely associated with Dr. C. Jeff. Miller for many years to become his biographer, because it is hard to strike the perfect mean



CHARLES JEFFERSON MILLER, M.D.

between a chronicle of the facts of his life and achievements and the deeper chords of personal reverence for a departed Chief and friend. Not only for this reason is it difficult, but because "Doctor Jeff" spoke so seldom of himself and allowed so little praise of himself, that, almost, his voice is

heard in deprecation of the homage we wish to pay his memory To those of his associates who knew him well, to his patients, and to many of his old pupils, it would doubtless be equally hard They held the man and the surgeon in deep veneration, he inspired them with confidence in his knowledge, faith in his wisdom, and dependence upon his unbiased judgment Daily, letters came to Dr C Jeff Miller—from doctors, asking for advice on problems of practice, from patients who seemed to think he could diagnose and alleviate their most minute difficulties—sight unseen, and from former pupils seeking his advice on medical questions

Dr Charles Jefferson Miller was born on February 9, 1874, at Winchester, Tenn, and passed his early life on his father's farm Tennessee might well claim credit for his education, for all his undergraduate years were spent there in the primary rural schools near his home, Terrill College, Sewanee, which he attended on a scholarship and from which he was graduated, and then the University of Tennessee, where he earned his M D degree in 1893

At no time in his career was he associated in practice with an older man, unaided except by the admiration, friendship, and respect of his confreres, he established a name for himself Although he was very young when he first came to New Orleans a few years after his graduation, his reputation as a surgeon of brilliance and sound judgment grew rapidly His fame spread not only in New Orleans and in Louisiana, but throughout the South, and he became eventually one of the leaders in his specialty with a professional standing not only national, but international

Almost from the beginning, his interest centered in gynecology As early as 1898, he was Visiting Gynecologist to Charity Hospital, New Orleans, and Chief of Clinic to the Chair of Gynecology and Obstetrics of Tulane University, under Dr Ernest S Lewis, as well as Lecturer on Clinical and Minor Gynecology at the New Orleans Polyclinic In 1910, he was appointed Professor of Clinical Obstetrics and Clinical Gynecology in the Tulane University of Louisiana, and in 1925, Professor of Gynecology and Obstetrics, becoming head of the Department in 1927, which position he held at the time of his death on March 21, 1936

Dr C Jeff Miller exerted perhaps the most universal influence upon gynecology in the South of any man of his time Through his teachings in the classroom and clinic, his writings, and his personal influence, he became the apostle of modern trends in gynecology at a period when many discordant voices were preaching confusing theories

But he was not a prophet without honor in his own country In 1897, a few years after his advent to New Orleans, he was elected Secretary of the Orleans Parish Medical Society, and in 1906, its President He was President of the Howard Memorial Library, New Orleans, a member of the Board of Control of the Louisiana Leper Home until it was taken over by the Federal Government Besides being Chief of a gynecologic service at Charity Hospital, he was also Chief of that department at Touro Infirmary

ary, Chairman of the executive committee of the staff of Toulo Infirmary, and a member of the Medical Advisory Board of Flint-Goodridge Hospital of Dillard University, a hospital for Negroes. He accepted no office merely for the civic, social, or business prestige it might carry, his interest centered in his profession and in those activities which were directly associated with it.

The esteem with which he was regarded all over the country is concretely evidenced by the honors he received. He was President of the American Gynecologic Society in 1928-1929, President of the American Gynecologic Club in 1927, Secretary of the Section on Obstetrics, Gynecology and Abdominal Surgery of the American Medical Association in 1908, and Chairman in 1912, President of the American College of Surgeons in 1930, and a member of the Board of Regents from 1926 until his death, President of the Southeastern Surgical Congress in 1936.

In 1898, Doctor Miller became a Fellow of the Southern Surgical Association, in 1920, Vice-President, and, in 1922, President. The work of this organization was always one of his chief interests. He attended the annual meetings faithfully, press of work sometimes kept him away, but it was only some unusual circumstance that prevented his going, for he looked forward to the opportunity these gatherings afforded of renewing old friendships as much as he did to the opportunity of witnessing the scientific attainments of the members of the Association, in which he took an active part.

Doctor Miller was the author of two widely used text-books. An Introduction to Gynecology and Clinical Gynecology, as well as of innumerable articles on scientific subjects and many of a medico-literary nature. He kept up with everything written on his specialty in the leading journals of America and abroad. His knowledge of the history of medicine was minute, and, always an interesting conversationalist, he was especially interesting on this subject. He was also an avid general reader, and many of his hours free from the rounds of professional routine and teaching were spent with books.

He enjoyed lecturing to his students and could never be persuaded to give up this arduous part of his life's work. He was especially interested in perfecting the standards of training both for undergraduates and for postgraduates who intended specializing in surgery. But he urged always in the classroom and in his writings that "the humanities of medicine" be not forgotten, or as he said in his inaugural address as President of the Southern Surgical Association: "Let us always be found defending the proposition that medicine is more than a science, that a skillful physician must be more than a scientist, that he must possess other knowledge that we usually refer to as the art of medicine or surgery, and that the possession of one without the other may be equally harmful."

And it was in that same address, 15 years ago, that he sounded an almost prophetic note of warning to the profession in regard to socialized medicine.

In 1930, Sewanee, recognizing his work toward the advancement of the science and art of medicine and the glory he had brought to his Alma Mater,

conferred upon him the degree of Doctor of Science "for his contributions to medical science"

We who knew him well lament the passing of a friend, an influence in our daily lives, a dearly loved preceptor. The medical world mourns the loss of one of its foremost surgeons and gynecologists, a great teacher, a captain in the march of medical progress. But we who suffered a personal loss in his going hold undying memories of him in our hearts. And in the medical world his teachings still live, his achievements are not forgotten. The words of Tennyson read at his last rites sound his last instructions to us.

"Sunset and evening star,  
And one clear call for me!  
And may there be no moaning of the bar  
When I put out to sea."

CURTIS H. TYRONE



## SOUTHGATE LEIGH

1864-1936

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DOCTOR SOUTHGATE LEIGH was born May 21, 1864, in Campbell County, Va., and died in Norfolk, Va., March 6, 1936. An only son of John Perivance and Fanny Cowdrey Leigh, he was left an orphan early in life and



SOUTHGATE LEIGH, M.D.

made his home with an aunt, Mrs. Pegram, for whom, in loving memory, he named the admirable hospital he built and operated to the time of his death. His early education was in the private school of Mr. Galt. After an academic and medical course at the University of Virginia under such able teachers as Doctors Cabell, Mallet, Towles, and Dabney, he received the degree in medicine, in 1888. Going to New York, he matriculated at the College of Physicians and Surgeons, Columbia, and was given a second degree of M.D. His internship was at Mt. Sinai Hospital where he was

directly under that eminent surgeon Dr Arpad Gerster, from whom he received honored consideration and was given special and prolonged service

A year in Vienna rounded out a well grounded medical education, and he returned to Norfolk, in 1893, and entered the practice of his profession

Endowed with abundant energy, he sought an outlet in clinical work and was largely instrumental in organizing the first Clinic at St Vincent's Hospital. He helped energize the old Retreat for the Sick, afterward the Norfolk Protestant Hospital, and was, by his vision, largely responsible for its present excellent topographic location. Later he built and administered the Sarah Leigh hospital and Clinic which now is in the process of being made a memorial to his memory through the activities of his many admiring friends. His driving energy led him to interest himself in the civic affairs of the city in which he held various important positions and in recognition of which he received the medal as "First Citizen" from the Cosmopolitan Club.

He was a faithful attendant at the meetings of many medical societies and was honored by the presidencies of the Norfolk County Medical Society, The Seaboard Medical Association, The Southern States Association of Railway Surgeons, Norfolk and Western Association of Railway Surgeons, Chesapeake and Ohio Association of Railway Surgeons and the Medical Society of Virginia.

He gave generously of his time and talents to his many patients, regardless of pecuniary reward, and also to his civic activities. His death came suddenly from cerebral hemorrhage while making a report of his successful effort to increase the membership of the Association of Commerce. As an evidence of the esteem in which he was held the funeral was attended by a very large gathering from all walks of the citizenry of the City.

Married, in 1905, to Alice Creekmore, she survives with two sons—Dr Southgate Leigh, Jr, and Watkins Leigh—and two daughters Mrs Martin H Capps and Mrs Lester M Minkel, both of New Jersey.

LOMAX GWATHMEY

#### EDITORIAL ADDRESS

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